BRITISH SOCIETY

FOR THE

STUDY OF ORTHODONTICS

1958

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Transactions of the

BRITISH SOCIETY FOR THE STUDY OF ORTHODONTICS

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1958

THESE transactions mark the Jubilee Year of the Society. Although the inaugural meeting was held in December, 1907, the first meeting under the Presidency of Mr. J. H. Badcock was held in January, 1908. The following quotation from the first Presidential Address is worth recalling: ". . .You may not all know that it is to Mr. George Northcroft and to him alone, that this society owes its inception. The dental world was supersaturated with orthodontic interest. Mr. Northcroft made the necessary movement and the British Society for the Study of Orthodontics crystallized out forthwith.

We thank him and hope that his labours will bear much fruit . . ."

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Glass, D. F.
Irwin, L. M.
Kerr, G. A.
McAlpine, A. M.
Page, G. Scott
Rumble, J. D.
Rumble, J. F. S.
Sandiford, H. E.
Scoones, J. M.
Taylor, B. P.
Thorn, N. K.
White, Miss B. E. E.

Lancashire
Angelman, J.
Batten, A. G.
Bush, P. G.
Capon, P. G.
Clifford, E. J. S.
Cruickshank, A. J.
Eirew, H. L.
Gall, A. J. M.
Grice, A. R.
Hartley, D. T.
Knowles, C. C.
Kurer, J.
Langford, L. F.
Lilley, W. A.
McCracken, J. I.
Miller, E.
Murray, Miss J. P.
Pogrel, H.
Robb, G. C.
Robertson, N. R. E.
Watkin, H. G.
Watkin, Miss P. A.
Whittaker, L. B.
Wild, N.

Leicestershire
Chamberlain, G. H.
Downing, F. J.
O'Brien, J. D.
Smith, K. A.
Smith, T.

Lincolnshire
Greenwood, A. W.

Middlesex
Baker, C. D.
Carr, A. S.
Dimock, J. R.
Eady, B.
Gould, M. S. E.
Hobdell, H. G.
Howard, R. D.
Hudson, J. A.
Levy, Mrs. H.
Lindon, Mrs. E. G.
Mandiwall, H.
Munns, D. I.
Rogers, D. A.
Strauss, K.
Swift, P. A.

Norfolk
English, Miss M. M.
Evans, H. R.
Steel, J. K.

Northamptonshire
Phillips, J. E.

Northumberland
Burke, P. H.
Hallett, Prof. G. E. M.
Littlefield, W. H.
Stubley, R.
Tinn, C. A.
Weyman, Miss J.

Nottinghamshire
Attenborough, J. L.
Frankland, W.
Hope, E. McLaren
Price, A. H. K.
Tredgold, H. V. G.

Oxfordshire
Harvey, P. D.
Hayton-Williams, D. S.

Shropshire
Broadbent, B. T.

Knight, J.
Scott, M. F.

Somerset

Alexander, J. M.
Poulter, N. M.

Staffordshire

Campbell, A. C.
Friend, Mrs. D. J.
Huddart, A. G.

Suffolk

Broadway, E. S.
Churchyard, R. C.
Clarkson, J. N. K.
Strange, Mrs. M. C.

Surrey

Bell, R. S.
Blackmore-Reed, C. P.
Bradley, Miss J. A.
Bulow, C. F. H.
Burnapp, D. R.
Friend, G. C.
Frischmann, I.
Heath, C. A. J.
Kelham, Miss M. M.
McIntosh, A. J. C.
Mayer, J. W.
Ogston, R. D.
Oliver, P. G.
Readings, P.
Reid, D.
Rice, V. G.
Ridley, Miss D. R.
Sarson, H. S. R.
Shepperd, R. V.
Smith, G. Richards
Sperryn-Jones, G.
Starnes, J. A. G.
Titford, K. R.
Tittle, J. J.
Vaus, K. S.

Sussex

Abbey, R. A.
Adam, K. W.
Allcorn, A. G. T.
Artes, E. J.
Barlow, E. T.
Bligh, A. J.
Brown, K. H.
Bull, F. Bocquet
Chisholm, I. M. G.
Cullingford, J. T. Powell
Dakers, G. H.
Edworthy, S. W.
French, J. H.
Graves-Morris, W. R.
Gray, N.
Greenwood, A. B.
Griffith, H. G.
Harwood, W. U.
Lees, K.
Martin, D. W.
Robertson-Ritchie, D.
Shenton, F. C.
Taylor, S. B.
Travis, C. H.
Whiteleg, J. G.
Winn, T. L.
Wylde, Mrs. A. S.
Young, Miss E. M.

Warwickshire

Breakspear, E. K.
Cutler, M.
Davis, Mrs. M. E. H.
Day, A. J. W.
Hollick, R. L. B.
Huggins, D. G.
Stanley, Mrs. V. K.
Tibbatts, Mrs. M. A.

Wiltshire

Campbell, Miss D. M. Y.
Godfrey, O. Harcourt
Horswill, P. N.
Swann, A. J.

Worcestershire

Edmonds, W. H.
Godfrey, W. G.
Hutton, J. L.
Mole, D. O.
Wallis, R.
Watkins, B. N.

Yorkshire

Alexander, Mrs. M.
Alexander, S. H.
Booth, M. H.
Cook, J. T.
Frazer, Mrs. J.
Gardiner, J. H.
Haynes, S.
Heylings, R. T.
Jackson, D.
Martin, J. H.
Park, E. W.
Porterfield, Lt-Col. M. F.
Priestley, P. J. M.
Sclare, Miss R.
Townend, B. R.
Webb, G. H.
Wood, Mrs. R. M.
Wood, T. Jason

III. Wales

Capleton, Mrs. L. M.
Cousins, A. J. P.
Duchesne, H. W.
Evans, W. D. P.
Hellier, R. O.
Jones, J. E.
Lewis, A. S.
Parry, H. L.
Wynne, T. H. M.

IV. Scotland

Aitchison, J.
Anderson, H. A.
Archibald, W. C.
Baker, A.
Brash, Prof. J. C.
Buchan, A.
Campbell, J.
Dixon, D. A.
Hopkin, G. B.
Houston, J. G.
Jones, F.
Kemball, C. H.
Logan, W. Russell
Logie, D.
McEwen, J. D.
McGibbon, D. M.
McGonigal, F.
Mears, Miss R.
Miller, Miss M. N.
Munro, D.
Murray, J.
Ritchie, G. S.
Webster, Miss E. M.
White, T. C.

V. Ireland

Adams, C. P.
Bonnar, Miss E. M.
Brown, W. A. B.
Dallas, H. A.
Dockrell, R. B.
Fitzgerald, G. M.
Friel, Prof. S.
Keith, J. E.
McKeag, H. T. A.

VI. Isle of Wight

Audsley, C. W.

VII. Colonial and Foreign

Africa

Bowen, E. J.
Braude, B.
De Villiers, J. F.
Fainsinger, B. E.
Maister, H. C. L.
Plint, D. A.
Robinson, F. F.
Williamson, M. M.

Australia

Adamson, K. T.
Halliday, R. W.
Heath, J. R.
Horsnell, A. M.
Norton, R. Y.
Reading, J. F.
Seward, J. T.
Spring, D.
Taylor, A. Thornton
Webb, V. P.

Belgium

de Coster, L.
Patcas, H.

Canada

Allan, F.
Franklin, G.
Hackie, T. J.
Mulligan, W. O.
Oliver, H. T.

Egypt

Bakry, A. L. H.

France

Demoge, P. H.
Gugny, G.
Omeyer, R.

India

Ghosh, A. S.

Iraq

Mirza, Y. H.

Malaya

Cheah, C. K.

Malta

Demajo, A.

New Zealand

Cook, C. C.
Gilbert, G. H.
Kean, M. R.
King, Mrs. W.
Lang, E. T.
Suckling, J. G.

Norway

Engh, Olav
Krogstad, Olav
Selmer-Olsen, Prof. R.

Singapore

Lee Chee Oun, J.

Southern Rhodesia

Crowther, Miss T. M.

Sweden

Granerus, R.
Granse, K. A.
Ljungdahl, L.
Lundström, Prof. A.
Mortenson, S. Å.
Palsson, K. F.
Tegner, G.
Volmer Lind, H. C.
Werner, S. H.

Switzerland

Hotz, Prof. R.

U.S.A.

Gillman, M. B.
Goldstein, M. C.
Gosman, S. D.
Gottlieb, A. W.
Hellen, Mrs. M.
Parfitt, Prof. G. J.
Sillman, J. H.

THE FUTURE FOR ORTHODONTICS

By **J. W. SOFTLEY**, B.D.S., F.D.S. R.C.S., D.Orth., D.D.O.

First of all I would like to express my thanks to you all for the honour you have done me in electing me your President in this important Jubilee Year of the B.S.S.O.

When I look back at the long line of distinguished men and women who have preceded me I am more than conscious of my own shortcomings. I can only say that I will fulfil the duties of this office to the best of my ability and try not to be too unworthy of those who have gone before.

This is the Jubilee Year of the B.S.S.O. and perhaps on this occasion you would expect from your President an address on a high philosophical plane or perhaps an exposition of some erudite piece of research. However, I have neither the qualifications nor the ability to embark on either of these ambitious projects and, with your indulgence and, I expect, to your relief, I will keep to the level of more ordinary mortals.

Among other meanings for "Jubilee" the dictionary gives it as a year of emancipation, of freedom from legal, social, or intellectual restraints. It is also a year of rejoicing, and we hope to mark it as such during the course of the year and particularly at the May meeting.

To-night I am interested in it as a half-way mark towards the centenary where we can pause and look back, estimate our progress, and, perhaps profiting from the experience of the past, peer a little into the future.

I have chosen the subject "The Future for Orthodontics" because it has been very much in my mind over the past year or two and because whichever way it goes it cannot fail to affect each one of us either directly or indirectly.

If we look back over the fifty years of which this Society can boast, we see change and much progress in orthodontics.

It has shared in the general advance of technology, and the application of new materials and processes have made possible advances in techniques and appliance design undreamed of at the beginning of our history.

More fundamental progress in the realm of real knowledge of certain aspects of our problem is such that anyone starting on an orthodontic career to-day is resting on a much surer foundation than his counterpart of fifty years ago.

That there were many successful orthodontists in earlier years is self-evident, but the many excellent results they achieved were, in most cases, due to an accumulation of clinical experience built up over a period of years rather than to the soundness of their theories.

Clinical experience itself cannot be transmitted to others. Mr. Maxwell Stephens (1928) in his Presidential Address of 1928 said:

"Though we honour ourselves by calling medicine a science, it is far from being a true science and the bulk of knowledge acquired in a lifetime of general experience is personal. It cannot be reduced to a system and set down in finality for others to assimilate."

Brash (1929) in his *Aetiology of Irregularity and Malocclusion of the Teeth* pointed out that very little positive evidence but a great deal of speculation had been produced to support the supposed causes of irregularity and malocclusion. The same charge could have been made, with justification, of attempts to explain results of treatment.

So that when our predecessors came to pass on the fruits of their experience to others they were hampered by the intrinsic difficulty of doing so and, in any case, could only do so in terms of knowledge which prevailed at that time. Sometimes by ascribing (what we now know to be) quite erroneous reasons for their successes it is not surprising that their pupils, in attempting to put theory into practice, fell into traps which long clinical experience had taught the teacher to avoid.

It is not pretended that the ultimate truth is known about all, or indeed any, of our problems, but considerable advances have been made and trial and error need not be the

Presidential Address given at the meeting held on January 13, 1958.

principal means of progress of a person starting orthodontics to-day.

But with all our progress it is vital to preserve a balanced outlook on orthodontics and orthodontic problems. There is no branch of dentistry where it is easier to rise into the clouds and there is no branch of dentistry where it is more important to have both feet firmly planted on the ground.

Orthodontics is not an exact science and it never can be. It must always lie somewhere between a science and an art. This has always been realized, I think, on this side of the Atlantic but not on the other, so that although, only half our history ago, Weinberger (1926) in the preface to his book on the history of orthodontics could say: "Orthodontics to-day is more nearly an exact science than any other branch of dentistry or possibly medicine . . .", there would be few in Europe who would agree with him then, and I doubt if he would be able to find one to-day.

Many attempts have been made to accept the science and to discount the art—to make a series of measurements, to apply a set of rules with the idea that by so doing a positive answer for successful treatment would automatically emerge, which (and this is important) could be applied by anyone acquiring a certain standard of technical ability.

It is interesting to speculate on the implication of the research outlined in the last Northcroft Lecture, but we should not imagine that the old-fashioned virtues of judgement and experience are likely to be ousted by sets of tables in the foreseeable future.

Attempts to practise orthodontics as a pure technology have always failed in the past and will always fail in the future. It is a professional occupation in the truest sense of the word, requiring not only knowledge but the ability to assess evidence, to come to a reasoned conclusion on that evidence, and to profit from experience. A sound theoretical background is an important adjunct to successful practice. It is not, and it cannot be, a substitute for clinical experience.

In the very nature of things clinical experience in orthodontics cannot be acquired overnight. Our predecessors built it up over a period of years. We should do better because our level of real knowledge is higher and our facilities for acquiring knowledge are better, but it is not possible to hurry the growth of patients. It is from the 16-, 17-, and 18-year-olds that the success or failure of treatment is learned.

Some reasonable continuity of experience in one place is desirable so that the results of one's own treatment can be seen and this has to be balanced against the value of moving around and obtaining other points of view. Without question private practice, where one stands or falls by one's own efforts, is the quickest way of obtaining experience.

There are those who take the view that dentistry is a small subject and that dental surgeons should be able to deal with it in all its branches including orthodontics. This is to ignore the lessons of the past and the clear evidence of the present.

The history of medicine, of which dentistry is a part, clearly shows the evolutionary trend towards specialization. There is always a stage where the demand for specialized knowledge exists but where the number of people trained to satisfy that demand is insufficient. Orthodontics is at that stage now, and until there are enough orthodontists to satisfy the demand the general practitioner is expected to deal with some of its problems.

The trend towards specialization has been going on since the beginning of the century, but the introduction of the Health Service, by unleashing an unprecedented demand for orthodontics, has focused attention on the shortage of trained people. As a direct consequence of this we have witnessed the rapid expansion of our speciality in the socialized field by the appointment of a number of Consultant Orthodontists.

The pattern of these appointments was intended to be set by similar ones in other fields, where a consultant advises and whenever necessary treats, either by himself or with the aid of the facilities at his command.

Like other specialities orthodontics produces problems peculiarly its own. There is a wide difference, for example, between the demands of ophthalmology and orthopædics. But the

only essential difference between orthodonties and other specialities is that at present the demand for its services is far in excess of the facilities available to satisfy them.

This state of affairs is likely to persist for some time. Already the expansion of the consultant service threatens to outrun the supply of competent orthodontists with the requisite clinical experience, and it will be no service to the community or to the profession to lower the standards.

I would remind you of the *Report of the Advisory Committee on Post Graduate Dental Education* (1947) where, referring to Consultants, it says that the status of Consultants in the sense understood in medicine is the product less of special training than of aptitude and experience.

As to why these appointments have been made, we should disabuse ourselves of the idea that the immense benefits we confer on the human race have at last been recognized. The truth, alas, is more likely to be that authority, confronted with concrete evidence of the failure of much orthodontic treatment, is making these appointments in the hope of saving money.

It is not suggested that failure in other branches of medicine is less common than in orthodonties, but irrefutable evidence is not so easy to produce.

And failure itself must be put into perspective. But orthodontists are not yet in a position of being able to predict the growth of individuals nor to predict the individual response to a particular stimulus. Consequently not all cases can be expected to succeed even when dealt with by experts.

The public are sometimes led to expect too much by ill-informed medical, and, I regret to say, dental, opinion which looks upon orthodonties as a simple matter of tooth movement.

But however rationally we may explain some of the failures, we should not be complacent, nor is it wise to ignore public opinion.

So that paradoxically it is to the failures of orthodontic treatment rather than to its successes that we owe the present official interest and the present expansion in our speciality.

The main reasons for failure are:—

1. Because socialized dentistry has unleashed a demand for orthodontic treatment far greater than the capacity of trained people to supply it.

2. Because the training is essentially a post-graduate study.

3. Because the teaching of the majority of those in private practice who are attempting to treat orthodontic cases was inadequate.

There is no doubt that teaching has improved, particularly in the post-war years. This is, in no small measure, due to the appointment of full-time teachers. They, by being able to give their whole time to teaching problems, have done extremely good work. In some cases they have been able to add to the store of knowledge, but it should be recognized that a good research worker is not of necessity a good teacher and the reverse is no less true.

There is also a price to pay for the success of full-time teachers. Part of that price is that by encouraging early specialization, general experience in broader fields is reduced, and as Mr. Maxwell Stephens (1928) said in the address I have already quoted, ". . . there is the ever-present danger that the part may shut out the whole".

This is a danger against which we must guard and it can be done only by keeping the basis of education as broad as possible.

The truth of this has been recognized by the Nuffield Foundation in the facilities which it has made available for teachers to study basic sciences. Their wider and more liberal outlook cannot fail to have a beneficial effect on the teaching of dentistry.

There is also a place, and a very real place. for the retention of some part-time teachers in dentistry and particularly in orthodonties so that they may keep, not only students but the full-time teachers, in contact with the experiences and problems of practice.

It is unfortunately true that while the present-day student has better opportunity for learning, the experience of many teachers and examiners is that they often fail to take advantage of their opportunities.

Mr. Hovell (1956) pointed to one of the reasons in his address of 1956 when he

reminded us that orthodontics does not always figure in examinations and that as the main object of an undergraduate is to qualify he tends to ignore anything not essential to that aim.

A Committee of this Society, reporting in 1922 and 1925, made the same point and said that the student qualified knowing less of orthodontics than of any other branch of dentistry. I fear this may very well be still true. Dental education in this country is not without tradition, and while tradition is often colourful and always interesting, it sometimes hampers progress in dentistry as in other fields.

My experience in the Dental School in Malaya, then only a few years old, showed to me the value of this fresher unhampered outlook on the presentation of dental subjects.

A great service could be done to orthodontics, and to dentistry as a whole, by a reshaping of the undergraduate curriculum—keeping and extending the tradition of association with medicine, giving more adequate instruction in basic sciences, dealing more imaginatively and less traditionally with such subjects as dental anatomy, so that the dental surgeon could see the orthodontic problems of practice in a truer perspective and not as mechanical exercises in tooth movement.

There might very well be fewer orthodontic cases tackled by the general practitioner, but those with more success.

However, I do not believe that orthodontics can be taught effectively to undergraduates and it must remain a postgraduate study.

While these proposals are designed to affect the outlook of future generations of dental surgeons we are obliged to deal with problems of the present.

There are very distinct problems when a consultant advises a dental surgeon on an orthodontic case. Success depends on a close understanding between the two people. The operator must interpret the orthodontist's meanings correctly and be able to put them into practice. He must also have sufficient knowledge of basic principles to know when a change of plan may be desirable.

It is usually reasonably easy to decide on the initial steps of treatment, but subsequent procedures depend on the response and any treatment plan drawn up at the start can only be tentative.

The alternative of exercising strict supervision over all stages of treatment defeats its own object—besides reducing the operator to the status of a robot carrying out procedures without understanding.

So one of the functions of a consultant is to replace the deficiencies of past teaching and to lead his flock of dental practitioners on to straighter if less expansive paths.

But however successful his efforts it will not affect the problem of dealing with the number of malocclusions, and this should be made perfectly clear to those in authority.

Another inquiry which this Society sponsored was into the need for orthodontists, and it was concluded that a trained orthodontist working full time could deal with 250 new cases of all types each year, giving a total of about 600–650 cases under treatment. For a five-day week this works out roughly at one new patient for every day of practice.

While many trained people can deal with more than this number, particularly if the clinic or practice is organized to treat them with trained ancillaries and so on, it is reasonable to say that general practitioners are unlikely to do so. So that if a general practitioner can give up one day a week from practice he will probably not be able to take on more than 50 cases per year.

He can only do this at the expense of a far larger number of his other patients, and if we accept current opinion, the number of active practitioners is likely to decline sharply in the next few years. Therefore with the best will in the world general practitioners are unlikely to be able to increase their contribution to the orthodontic problem.

Similar argumcnts apply to the school dental service. School Dental Officers can only make an effective contribution to the treatment of malocclusions at the expense of their other duties. As this service is grossly understaffed at present it would appear senseless to divert effort away from its main purpose.

This is not to say that the general practitioner and the school dental officer have no

contribution to make. One cannot be a consultant orthodontist for long without being aware of the enormous amount of orthodontic effort which is being wasted on patients who do not appreciate it, and in many cases do not even want it.

Their contribution does not lie so much in teaching them to make appliances for more and more patients, but in ensuring that the facilities which are available at present are not wasted. This means much greater care in selection of patients than is now being exercised.

In assessing the need for orthodontists it is important not to base the estimate on the number of malocclusions but on the number of malocclusions which should be treated. Any saving in resources would be much better spent on teaching the younger generation to take care of the teeth they have or to developing the school dental service.

However desirable orthodontics may be, it is essential to preserve a balanced outlook and admit that an orthodontic service should only be superimposed on the foundation of an efficient dental service and on a population which will care for its teeth.

I have tried to show that general practitioners would be unable to make much impression on the number of orthodontic cases requiring treatment even if the desire to do so was there.

My experience convinces me that only a small minority of them do wish to treat cases and that the remainder would be quite content to get rid of all, or of all but the simplest, of their orthodontic problems.

The consultant is of value to those who are already interested and who consult him and possibly with his help they may treat a few more patients. He is of value to the remainder only in so far as he can take cases off their hands. To believe that the appointment of consultants will enable practitioners to treat a number of cases which they never did before is merely wishful thinking, and it appears to be worse than useless to advise treatment where the practitioner is unable or unwilling to carry it out.

I have dealt with the problems of the consultant orthodontist at some length because it is likely that the future for orthodontics in this country will depend on the way this service is developed. The appointments which have been made so far are not ends in themselves; they solve very few problems.

The closer the problems are examined the more irresistible is the conclusion that in the Health Service in this country orthodontics will most likely be dealt with by a full-time service.

The ultimate level of the service will depend on how much the country can afford to spend and that will depend on how much value it obtains for the money.

I therefore believe that what is required at present is not a scattering of orthodontic effort over the whole country but a concentration and development in the areas where appointments have already been made so that real service can be given. The experience so gained can be gradually extended and experienced people will be available.

By all means encourage the general practitioner experience which is available, by the creation of such posts as clinical assistants, but the training of general practitioners should not be the ultimate aim, for in essence this is an attempt to substitute the consultant for the rule of thumb, which has proved disastrous before.

Socialized dentistry in this country has been characterized by an attempt to do too much with too little resources, to dissipate effort with the result that little has been achieved for the effort which has been expended. Let us at least give warning to avoid this mistake in orthodontics.

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DISCUSSION

Mr. G. C. Dickson said that he would like to thank Mr. Softley for asking him to open the discussion on his address and for letting him have a copy of it a week or two in advance. He had read it through three or four times and there was a good deal in it with which he wholeheartedly agreed. There were, however, certain aspects of it on which he would like to comment.

He could not help feeling, although he might be wrong, that Mr. Softley had rather dwelt on the necessity for experience. He would be the last person to say that experience was not necessary but it depended upon what was meant by experience. A man could do the same thing wrongly for thirty years and call it experience. Experience was essentially the subconscious pigeonholing of little facts and items of information about a patient and his response to treatment which could eventually be drawn upon in treating subsequent patients. He thought that there was no theoretical reason why eventually orthodontics should not become a science. He said "theoretical" because there was obviously the practical limitation that they were unlikely to find a mind, without experience, which could assimilate all those facts.

He would like to quote from a recent essay by Sir Julian Huxley, written under the title "Science in a Free World". "History demonstrates that the best method for securing advance and improvement in awareness and so for securing human progress in general is the scientific method—in other words, going into facts, questioning them, framing hypotheses about them, testing hypotheses against the facts. It is through this dialectic exchange between brute fact and human reason that we discover new facts and new regularities which lead on in their turn to new hypotheses and new discoveries and to a gradually increasing body of ever more firmly established truth."

That had not been written about orthodontics, but it could well have been and orthodontic thought was now proceeding on those lines. He would like to put in a plea for that approach. He fully realized that at the moment experience must play a very large part in the training of the orthodontist but he hoped that in the future it might play a lesser part.

There were two other points in the paper on which he would like to comment. One was simply the statement of the bald fact that Mr. Softley thought that the general practitioner could treat very few orthodontic cases. He confessed that although the number was obviously limited, his experience as an orthodontic consultant had been more heartening in recent years in that respect. He thought dentists, particularly those who had qualified since the war, could take on an appreciable number of cases and that, of course, brought him to the second point, which was that the thing that those in the hospital service felt that they lacked most of all was about six pairs of hands.

There was, as Mr. Softley had said, a large number of cases to treat, but he would put it to him that the training of the orthodontist was very largely mental and that the practical training could be compressed into a small number of years. The practical training was a question of manual dexterity which could be acquired in a shorter time. Therefore, in order to make the best use of the available material he thought that use should be made of other people's hands.

Mr. Softly had mentioned that he approved of clinical assistants. A couple of years ago, when he himself had opened the discussion on Mr. Hooper's paper, he had been criticized for suggesting the appointment of senior hospital dental officers. Some people might not know what was meant by the term "clinical assistant", but essentially it was a grade of appointment used a lot in the hospital service in which a general practitioner came into a specialized clinic to assist the specialist on a part-time basis, usually for one or two sessions a week. In that way not only was the orthodontist able to have the use of someone else's hand to treat his cases but he was training a potential assistant—a practitioner to whom he could refer cases for treatment with confidence. He would like to ask Mr. Softley whether he did not consider that expansion on the lines of clinical assistants might be of value.

There was one further point which he would like to make. He often felt when he was standing and waiting for Zclex to set that the taking of impressions and the making of bands were mechanical procedures and that apart from the physical exercise and the mental relaxation involved there was no value in doing those things. He wondered what Mr. Softley thought of the suggestion of using dental ancillaries for taking impressions and making bands.

The President, in reply, said that he had made a point when speaking about experience, that it was not only experience but the ability to profit from it which was of importance. He agreed that people could do the same thing wrongly for thirty years and therefore suggested the value of moving around and getting other ideas. If a person could not profit from experience he would be no good at orthodontics or at anything else.

While he agreed that practical training could be compressed to a certain extent there was nevertheless a limit beyond which it could not be compressed. His experience of teaching and of people doing postgraduate work was that it took at least a year or so before the pennies began to drop. The first year merely increased the confusion and only gradually was that confusion dispelled. He agreed about the value of the scientific method of approach, and clearly many of the problems would have to be solved that way, but people had to practise orthodontics and the people who were applying the scientific method were in the main people who were doing research.

He was glad that Mr. Dickson was more optimistic than he was himself about the contribution which the general practitioner could make. He had recently tried to find out what had happened to a number of cases he had seen in one area. He had found that 25 per cent, or something over, of the cases which he had seen and for which he had advised treatment, had in fact received no treatment for various reasons, usually because the patient had not come back or had decided not to proceed. The important point was care in the selection of patients.

He would be entirely in favour of clinical assistants. They had, in the foreseeable future, a great part to play, but he would emphasize that in his view it was a limited part and that they could not in fact deal with the orthodontic problem of dealing with the mass of people who were clamouring for treatment. He did not think that it could be done that way.

He supported the idea of dental ancillaries.

Dr. W. R. Burston said that he hoped he would be forgiven if he prefaced his remarks with one or two personal observations. He and his colleagues in Liverpool took great pleasure and not a little pride in seeing their old chief, Mr. Softley, in the position which he at present occupied. He was, alas, no longer with them at Liverpool but he had left with them a fine tradition of service. Dr. Burston was more than indebted to Mr. Softley for all he had done for him during the time he was privileged to serve as his second in command.

He would like to comment on one or two points in Mr. Softley's address. The first point was the question of orthodontics as an art and as a science. Science had come to be regarded as something "exact", but surely the "degree of exactitude" that could be achieved in any given problem was determined by the precision with which that problem could be stated. Even a subject such as Physics was now having to recognize this fundamental limitation. How much more true was it then of biological science where it was extremely difficult to state a problem in precise and meaningful terms. In orthodontics most of our terms were qualitative and arbitrary, bearing little relation to the vital processes involved in growth. How then could it be hoped, as had often been tried, to resolve clinical problems with the exactitude of a mathematical equation? Surely this was where Science failed in the solution of clinical problems and Art stepped in.

The President had reviewed the last fifty years in orthodontics and it was interesting to compare this with the history of morphology. Down the ages morphology had recognized two schools of thought—the formal and the functional. Formal morphology based its study of development on the concept of the "archetype"—the common plan—to which all animal form tended.

The absurdities which the logical extension of this concept achieved were there for all to read in the writings of the German school of transcendental anatomy. Philosophically speaking there was not one whit of difference between formal morphology and the concept of idealized occlusion and idealized skeletal form. In that sense orthodontics had recapitulated in fifty years what morphology had passed through in 2500 years.

On the other hand, functional morphology was more concerned with the means by which form was attained. It dealt with the way in which the various tissues interact —the correlation of the parts—the concept of the whole of an individual organism balanced not only with its environment but more particularly within itself. Surely this was the heart of the orthodontic problem. What was constant from individual to individual was the methods Nature used in progressing from stage to stage in development. An understanding of these "developmental horizons", not only within the jaws, but also in the body as a whole, would go far to solving many orthodontic problems. Orthodontists were privileged, as were few others, to witness development taking place, since the teeth and jaws had such an extensive post-natal development as compared with other organs of the body. It was their main task to study the interplay of the various tissues and how this could be modified to produce a desired result.

One of the principal difficulties was the confused orthodontic terminology which clouded the real nature of clinical problems. So many clinical clichés were in use —a form of shorthand, which in many cases had a variety of interpretations—that a precise statement in these terms was impossible. The speaker had tried explaining orthodontic problems to students in the simple terms of anatomy. This had been a very interesting experiment from his point of view because he had seen how the paucity of knowledge was covered up by the use of clichés. Once such terms as "post normal case" or "Class II case", etc., were forbidden it was amazing how much more thought and care were required in describing a given condition and how the real nature of the problem became apparent.

Turning to the practical aspect of orthodonties and in particular to treatment for the masses, the overriding problem in the Liverpool area was of first securing effective general dental treatment, without which orthodontic treatment was largely a waste of time and effort.

With regard to individual consultants working with large numbers of general practitioners, his own view was that unless an individual was looking after a patient all the time and seeing development taking place, the case could not be treated effectively. Many orthodontists found that they had to modify treatment in consequence of an original failure to assess developmental possibilities correctly. It was very difficult to see patients at irregular intervals and at the same time get to grips with what was taking place. For that reason he did not think that one orthodontist could cope with very large numbers of patients.

He would like to thank Mr. Softley for his most interesting and instructive address.

Mr. J. H. Hovell, after thanking Mr. Softley for his address, said that when he himself had given a Presidential Address, discussion had been stifled by the proposer and seconder of the vote of thanks who said that presidential addresses should not be discussed. He personally did not propose to disappoint Mr. Softley in the same way.

He disagreed with a great deal of what Mr. Softley had said regarding the future of orthodontic consultants. In fact he thought that the President had contradicted himself. In the first place he had said that he thought orthodonties would be better taught in the schools and then he had said that it was a postgraduate specialty and not an undergraduate one. He could not have it both ways. Either it was taught in the schools or it was part of the postgraduate system. Physiology, anatomy, comparative anatomy, and orthodonties were the basis of the teaching of the whole of dentistry. He did not think that general dental diagnosis and treatment planning could be taught properly unless orthodontic diagnosis, which was the basis of the former, was also taught to the dental student. When qualified the dental student had to know all that he could be taught about orthodonties in that respect.

With regard to treatment he agreed with what had been said by Mr. Dickson. He thought that treatment was technique. The actual construction of orthodontic appliances, whether fixed or removable, was far simpler than the construction of bridges and jacket crowns. That general dental surgeons should not be encouraged to take part in the orthodontic service he did not believe. The fact that the majority of those who qualified before the war had no knowledge of present-day orthodontic diagnosis and treatment was no argument against including orthodonties in what the dental surgeon of the future could do. He thought that any consultant who did not in his area encourage an interest in orthodonties and did not give talks and organize study groups was failing in his duty as a consultant orthodontist.

The President, in reply, said that he was aware of the apparent contradiction in what he had said but he did

not think that in fact it was so. He believed that great improvement could be made in the teaching of orthodontics in schools and he believed that from that the practitioner would be able to appreciate the problems of orthodontics. But that was a far cry from dealing with the orthodontic problem and he still maintained that the general practitioner was not capable of dealing with the mass of orthodontic cases which expected treatment.

He agreed that technique itself was comparatively simple. Some techniques were more difficult than others, but the application of those techniques was not easy. His experience of post-war students was that although they were a little better than the pre-war ones he did not think they were capable of dealing with complex orthodontic problems. He felt absolutely certain of that.

Mr. S. G. McCallin said that he enjoyed the President's address very much. Following on what had been said by Mr. Hovell he would like to support his contention that general practitioners should be in a position to call upon a consultant to receive assistance on diagnosis and treatment planning. In the past ten years he had dealt with large numbers of cases, referred to him by practitioners, at the Eastman Dental Hospital, and while it was true that as the years went by many of these practitioners fell away and did not refer further cases, this might be his fault since he probably prescribed treatments which were beyond them to carry out. Nevertheless a hard core of interested general practitioners was beginning to emerge who sent more and more cases for opinions and evidence was growing that they obtained good results.

He would also like to support Mr. Hovell's point that a regional consultant was not only obliged to see large numbers of referred cases but also to encourage interested general practitioners in his area. In his view, with the right encouragement many of these general practitioners would enjoy doing exceedingly good work.

Mr. Dickson had pointed out how difficult it was for a student who had acquired some theoretical knowledge to obtain a post where he could gain practical experience. It seemed to him that opportunities should be created for a man who has spent perhaps two years studying, to gain further experience under partial supervision. Possibly more senior registrar appointments might solve this problem. There was no real substitute for prolonged clinical experience especially if regional consultants were going to be able to assist general practitioners in their area with their practical problems.

The President, in reply, said that he was sorry but he could give no assurance at all on that point. He had no idea whether in fact by to-morrow the powers that be would not say that orthodontics was not to be practised by the general practitioner. He appreciated the amount of good work which people who had specialized over a long period were doing. Of course, it was those people in particular that the consultant orthodontist could help with their problems. A great many people did in fact come along and bring their cases and ask about them and it appeared that they derived considerable help from so doing.

Mr. J. F. Pilbeam said that he would like to join the other speakers in expressing grateful thanks to the President for his excellent Presidential Address.

Reference had been made in the address to the tremendous magnitude of the problem of providing orthodontic treatment for the masses but it had seemed to him, at any rate in the past two years, that orthodontists had given so much time to deciding many cases were untreatable that the problem was solving itself.

In his opening remarks the President had referred to consultant appointments in the Regional Hospital Board Service and he had implied that that was a natural thing to expect to follow the setting up of a socialized service. Personally, he did not think that it had been quite so simple as that. Those who had been interested in encouraging the setting up of a consultant orthodontic service in the Regional Hospital Board Areas would agree with him when he said that it had been a very uphill and difficult task to establish such appointments. A tremendous amount of hard work had had to be put in to get those appointments and, indeed, to get orthodontics considered as a specialty at all. As a result of a great deal of effort through the Society there had come the considerable achievement of establishing orthodontics as a consultant specialty, recognized as such by the Ministry of Health.

This ideal had been foreseen in a Report published by the Society as long ago as 1942. It was very pleasant to see that the recommendations put forward in that Report had at last been implemented, not as a means of saving money as our President suggested, but because orthodontics had established itself as a true specialty of dentistry.

The President had also referred to dental education and orthodontics. The Report to which he had just referred had mentioned the question of the teaching of orthodontics in the schools and the majority recommendation was that the teaching of orthodontics in schools should be very limited indeed—limited to the teaching of simple diagnosis so that the student was left, when he qualified, to seek other means through postgraduate training for further education in orthodontics if he so desired.

After meeting a large number of students who had qualified and who had come from schools which had adopted that recommendation and also from schools which had not, he would throw in his weight with those schools which did not teach orthodontics. He thought that students had become better orthodontists when they had trained by means of postgraduate courses.

He was very disappointed that the President felt that the general dental practitioner could not play a very important part in the development of the orthodontic service. Personally he would have thought that the consultant orthodontist could have utilized the keenness that was very evident with a large number of practitioners, by appointing clinical assistants for two years and so develop a service which would encourage a large number of dental surgeons to be interested and also to do a certain amount of work under consultant guidance. If there was some regularity about it he thought that the consultant could treat a tremendous number of patients with the help of the general practitioners.

He hoped that in the field of orthodontics, without having too many extravagant ideas, they would eventually have house surgeons, registrars, and senior registrars in the hospital departments so that through the Regional Hospital Boards hospitals more orthodontists could be trained to fill the larger number of vacancies which would arise in the next few years.

While on the subject of the training of orthodontists he would like to say it was a little disappointing that the Eastman Dental Hospital, set up a few years ago as a

dental postgraduate centre, had trained so few people in orthodontics. He hoped that that deficiency would be made good eventually by means of Regional Hospital Boards training their own consultants.

Lastly, he would refer to the question of selection of patients. He thought he could claim to have had some experience in the organization of orthodontic services in various fields and he had always said, and he knew that a lot of people who worked with him agreed, that orthodontic treatment should not be undertaken unless there was complete co-operation between the child and the parent. The best way of finding out whether there would be such co-operation was to ask the parent "Are you concerned about your child's appearance?" If the mother was not concerned then that child would not be a suitable one to treat. By means of that simple method of selection it was possible to reject a number of children who would probably prove to be unsuitable patients.

The President, in reply, said that possibly he had taken a rather more cynical view of some of the problems than the speaker would have liked. He had been interested to hear from Mr. Pilbeam, who had been concerned with the appointments in the Regional Hospital Board Service, of the fight there had been to create a consultant service. So far as he could understand it Mr. Hovell did not want orthodontics to be a consultant service but wanted the general practitioner to deal with all cases. Again, it was not possible to have it both ways. It was either easy, in which case anyone could do it, or it was difficult.

He agreed that use should be made of the general practitioners who were willing and able to deal with orthodontics, and that they should be encouraged. He had not intended to imply that that should not be done. He considered that such people should be used and the consultant must help them. Nevertheless he did not think that the whole of the problem could be met by the general practitioner. He agreed entirely that other grades such as that of registrars should be appointed in the hospital service as well as consultants. He did not think that there should be consultants only.

Mr. J. C. Ritchie said that he had very much enjoyed the President's address, because he felt that his feet were planted so firmly on the ground. There was just one appeal which he would like to make and that was that in teaching orthodontics, both undergraduate and postgraduate, those who taught should not have their vision clouded by the present era of socialized dentistry. It was only by workers in the orthodontic field exploring new avenues, that progress would be made. If teachers took the view that it was no use teaching a certain thing because the Dental Estimates Board would not approve, they would be going backwards. A great deal was heard at the present time of difficulty and frustration among practitioners. In their teaching of orthodontics they must keep their view absolutely clear and unfettered by Government control.

Mr. G. C. Dickson said that it was only in recent years that it had been customary to discuss the Presidential Address. There was, however, a rather older custom, which it fell upon him to carry out that evening, and that was to propose a vote of thanks to the President for his address.

Mr. Softley, of course, was no stranger to members. While he was in Liverpool and travelling was difficult they had not seen as much of him as they did now that he was at Oxford. He was now Orthodontic Consultant to the Oxford Regional Hospital Board and he had developed the orthodontic service in that area. He would like to say on behalf of the members how pleased they were to be able to look forward in the jubilee year to Mr. Softley's penetrating thought and urbane wit from the President's chair. It was with great pleasure that he proposed the vote of thanks.

The vote of thanks was carried with acclamation.

THE DEVELOPMENT OF THE JAWS

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THE progress of dental science can be assessed in two ways: first, by advances in the treatment of oral disease and, secondly, by the extent of the knowledge, both of a functional and aetiological nature, which enables us to explain the treatment of the abnormal on a rational basis. Thus, the underlying reason for a consideration of the manner in which the bones of the facial skeleton differentiate, develop, and grow is that knowledge of these processes is essential for a fuller understanding of abnormal development of this region of the skull.

The development and growth of the jaws are best considered as two distinct stages in the attainment of their adult form. Growth of the jaws is a complex problem intimately concerned with the aetiology of malocclusion and an extensive literature exists which attempts to classify the various causative factors predisposing towards these deviations from the normal. It is not the intention of this paper to extend this aspect of the problem.

Fortunately, before the jaws can grow they must develop, and the stages in their development can be described much more precisely and inferences more readily determined. In scope, the present paper is therefore confined almost entirely to the early developmental history of the jaws and some applications of this knowledge to the aetiology of dental disorders.

A considerable literature may be found which deals with the development of the mandible, doubtless because of its relatively simple form and lack of complex morphological relationships with other skull elements. In contrast, reference in the literature to the development of the upper jaw is more limited (Dixon, 1953). This has resulted in a persistent emphasis on the developmental history of the lower jaw and the consideration of the two jaws as quite separate entities.

This occasion affords an opportunity to study the jaws as a single developmental and functional unit, bringing to light certain significant and comparable patterns of development which the study of one bone only might overlook. Furthermore, it will be of interest to note the relationships of the jaws to structures most closely associated with them during their development, namely, nerves, cartilaginous elements, and the dental lamina and tooth germs. Although we cannot hope to obtain conclusive evidence without experimentation we may see whether or not the developmental pattern supports the hypothesis that the early differentiation of the jaws is induced by such structures.

FEATURES OF FACIAL DEVELOPMENT

The embryological processes which make up the soft tissues of the human face are the mandibular, maxillary, and frontonasal processes. Fusion between them by disintegration of their ectodermal coverings normally occurs early in embryonic life, before ossification of the jaws begins. It is extremely difficult, therefore, particularly in the case of the upper jaw, to relate the boundaries of these processes to the position of ossific centres. Although some authorities (e.g., Arey, 1953) maintain that the philtrum or median part of the upper lip is formed by the lower part of the frontonasal process, it is now generally accepted that the maxillary processes meet one another in the midline, the lower part of the frontonasal process being submerged beneath them. Boyd (1933) provided adequate evidence for this concept from an embryological study of the upper lip in a number of mammals.

Typical coronal sections through the facial region of human embryos, best represented by a diagram (*Fig.* 1), show key structures to which frequent reference will be made throughout the paper. At the top of the diagram are

Given at the meeting held on February 10, 1958.

the forebrain vesicles, which later will differentiate into the lateral ventricles of the cerebral hemispheres. Just below them the mesodermal septal process with its ectodermal covering projects downwards into the common oronasal cavity, contains the cartilaginous

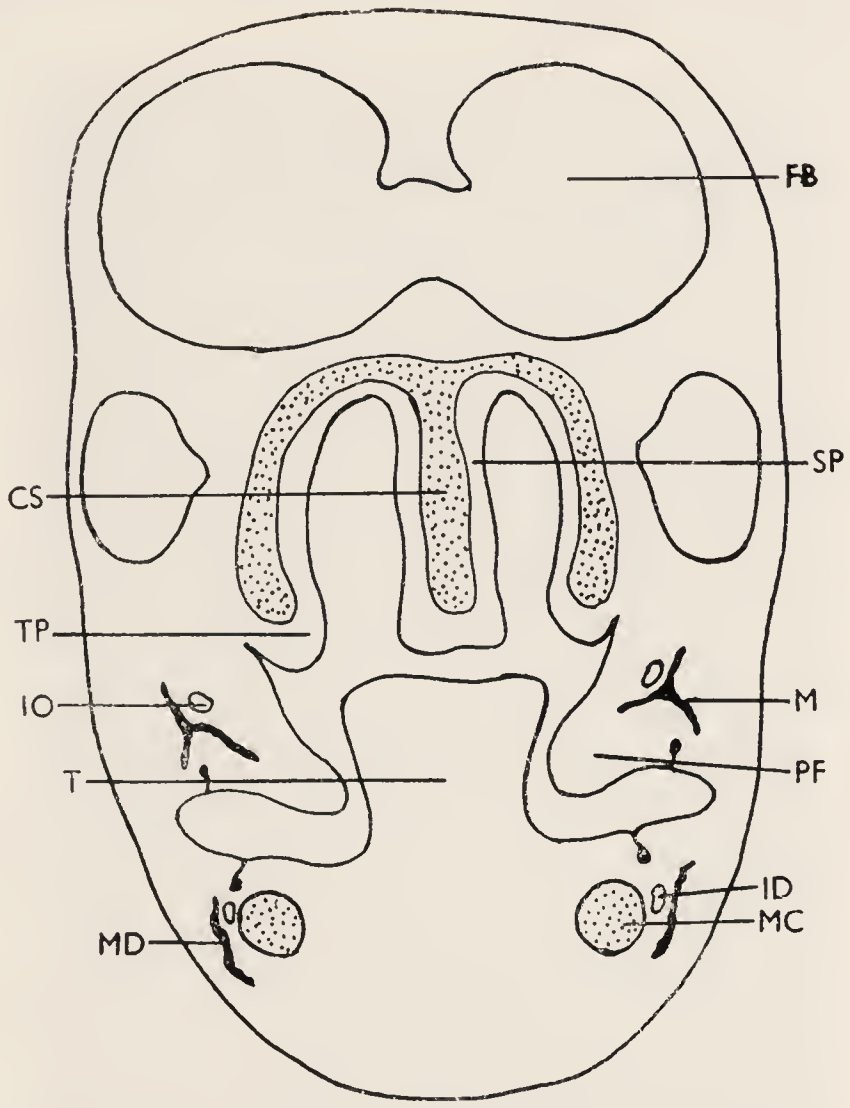

Fig. 1.—Camera lucida drawing showing key structures in a coronal section through the facial region of a human embryo. CS, Cartilaginous nasal septum; FB, Fore-brain vesicle; ID, Inferior dental nerve; IO, Infra-orbital nerve; M, Maxilla; MC, Meckel's cartilage; MD, Mandible; PF, Palatal fold; SP, Septal process; T, Tongue; TP, Turbinate process.

nasal septum, and ends a short distance above the dorsum of the tongue. The upper extremity of the cartilaginous septum continues first laterally above the oronasal cavity and then downwards to form the lateral wall of the nasal capsule, terminating in the substance of the inferior turbinate process. At once one readily obtains the impression that the nasal capsule as a whole is maintaining the patency of the respiratory part of the oronasal cavity and is acting as the primitive skeletal support for the upper face.

The soft tissue palatal folds at present project downwards at the sides of the tongue but will later pass inwards above it to fuse with each other and the inferior border of the septal process. In the central part of the maxillary process, at the base of the palatal fold, the maxilla is at an early stage of its development, forming a small bony mass in relation to the infra-orbital branch of the trigeminal nerve.

At the same time in the mandibular process the mandible is becoming established in relation to the inferior dental nerve, on the lateral aspect of Meckel's cartilage, which forms the primitive skeleton for the lower jaw.

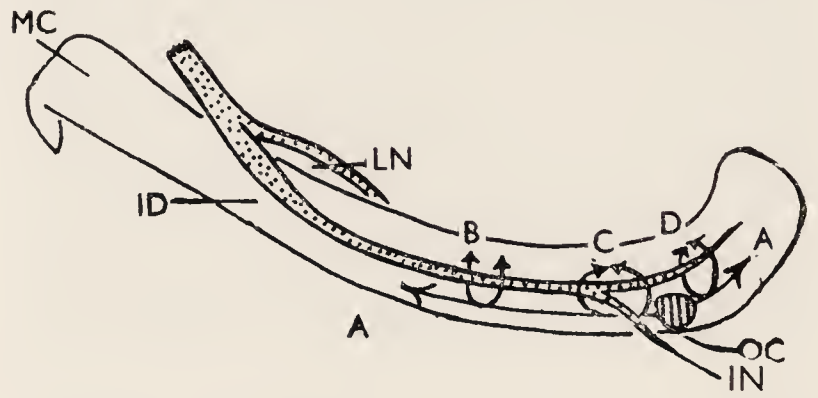

Fig. 2.—Diagram showing the centre of ossification of the mandible and the directions in which bone spreads from this centre. ID, Inferior dental nerve; IN, Incisive nerve; LN, Lingual nerve; MC, Meckel's cartilage; OC, Centre of ossification. For explanation of A–D *see* text.

DEVELOPMENT OF THE MANDIBLE

The inferior dental nerve crosses the superior, or cephalic, surface of Meckel's cartilage (*Fig.* 2) and passes forwards on its lateral aspect to divide into terminal mental and incisive branches a short distance from the enlarged anterior extremity of the cartilage. About the 15-mm. C.R. length stage, or during the sixth week of intra-uterine life, a centre of ossification appears in the angle formed by the mental and incisive branches of the main nerve trunk. From this centre (OC) bone formation spreads rapidly (A) forwards towards the midline and backwards along the outer side of the cartilage, forming a bony shelf below the inferior dental nerve and its branches. The appearance of the ossific centre is of an intramembranous nature and is quite divorced at this stage from Meckel's cartilage. Histological sections from a 15-mm. C.R. length embryo show the ossific centre in the coronal plane below and between the mental and incisive nerves (*Fig.* 3).

Mesodermal cells form a condensation in the midst of which small islands of osteoid tissue accumulate. In this embryo there is a marked increase in the vascularity of the ossification zone, and the oral epithelium can be seen at the top of the photograph (*Fig.* 3).

Bone development not only spreads rapidly in an anteroposterior direction, but also

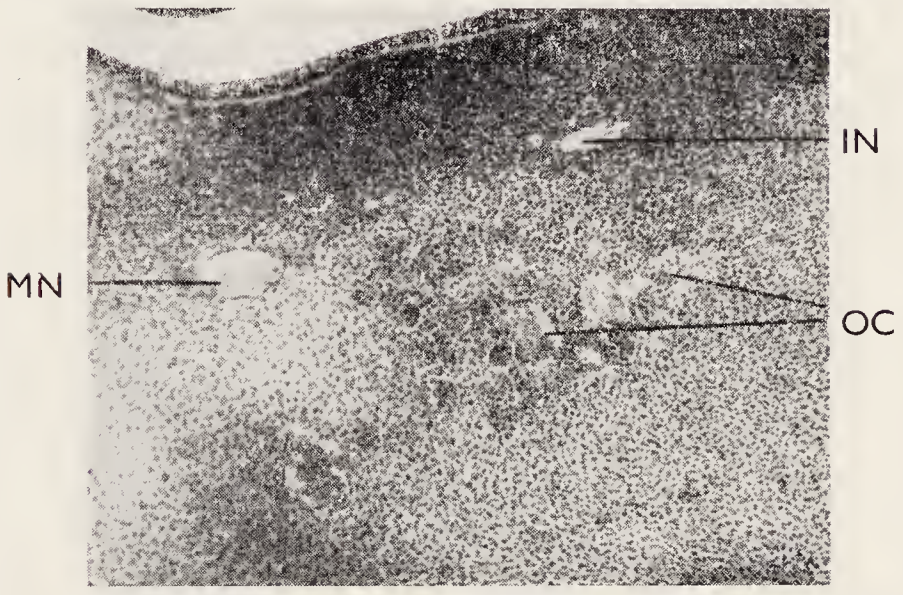

Fig. 3.—Coronal section through the centre of ossification (OC) of the mandible in a 15-mm. C.R. length human embryo. IN, Incisive nerve; MN, Mental nerve.

upwards on the lingual and buccal aspects of the nerves to form a trough or gutter around them (B, *Fig.* 2). The buccal plate becomes divided to pass around the mental nerve but closes again above it, thus completing the formation of the mental foramen (C, *Fig.* 2). In front of this region the outer and inner plates approach one another over the incisive nerve, eventually forming a tunnel or canal in which the nerve lies (D, *Fig.* 2). Coincidently the mandibular bone begins to envelop Meckel's cartilage on its upper and lower surfaces. Horizontal sections through the mandibular process of a 33-mm. embryo (*Fig.* 4) indicate the anteroposterior extent of the mandible. The buccal plate, which is extremely thin, follows the curvature of Meckel's cartilage but is separated from it, in this section, by the inferior dental nerve. Towards the future symphysial region both walls of the neural gutter are visible. Already the musculature of the tongue is well differentiated, the lingual nerve passes forwards along the inner side of Meckel's cartilage, and on the outer side of the mandible the masseter muscle is sharply defined.

In this manner the primary or neural element of the mandible is established, which will give rise in later life to the greater part of that substance of the lower jaw termed the basal bone. One must emphasize again its close relationship to the nerves of the mandibular process and its dependence for its form on Meckel's cartilage.

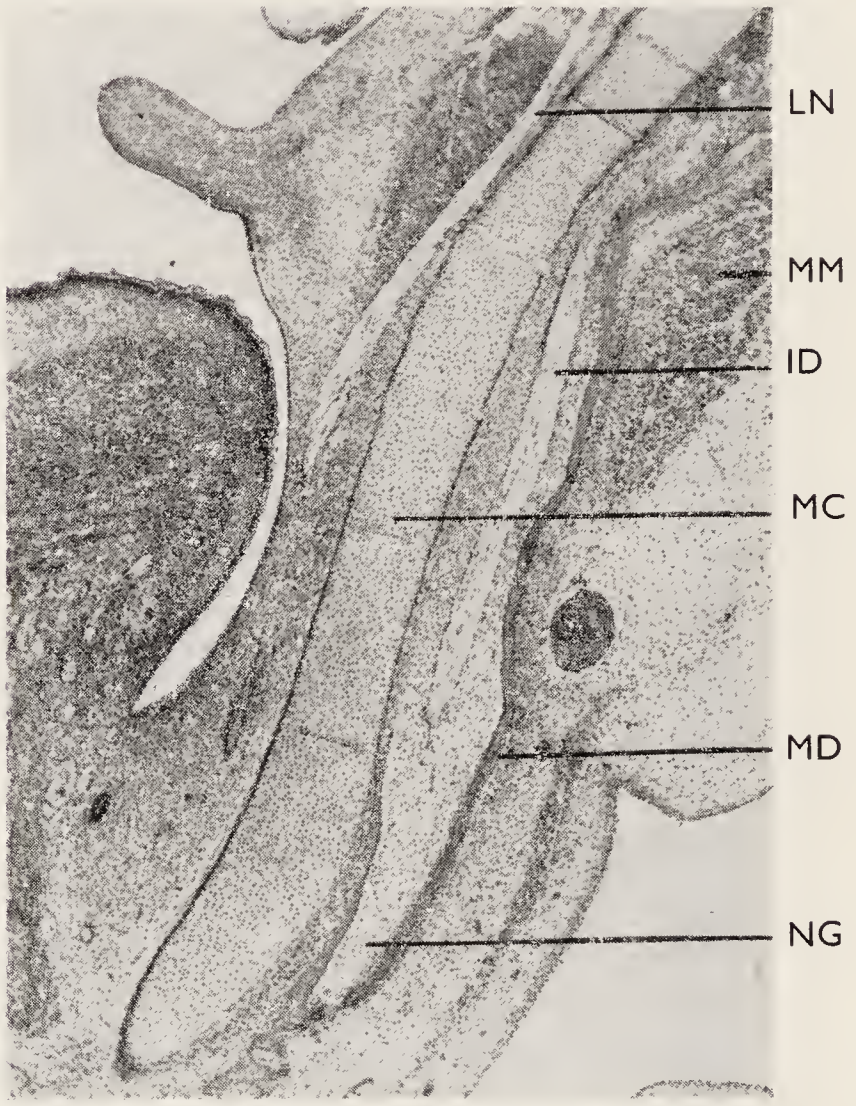

Fig. 4.—Horizontal section through the mandibular region of a 33-mm. C.R. length human embryo. ID, Inferior dental nerve; LN, Lingual nerve; MC, Meckel's cartilage; MD, Buccal plate of mandible; MM, Masseter muscle; NG, Neural gutter.

By the time the neural or basal element is firmly established the tooth germs approach the bell stage of their development. To afford support and protection to the developing teeth a new bony element is added to the existing neural element, namely the alveolar plates. These appear from the outer and inner lips of the neural groove and push their way towards the oral epithelium, obviously influenced in their primary direction by the position of the developing teeth. A coronal section from a 44-mm. embryo (*Fig.* 5) emphasizes this new stimulus to mandibular development, for histologically the alveolar

plates are not merely a further extension of the walls of the neural groove but are seen to be a definite new addition to that structure.

In the same photograph the disproportion in size between the mandible and Meckel's cartilage is noticeable. The cartilage does not attempt to keep pace with the growth

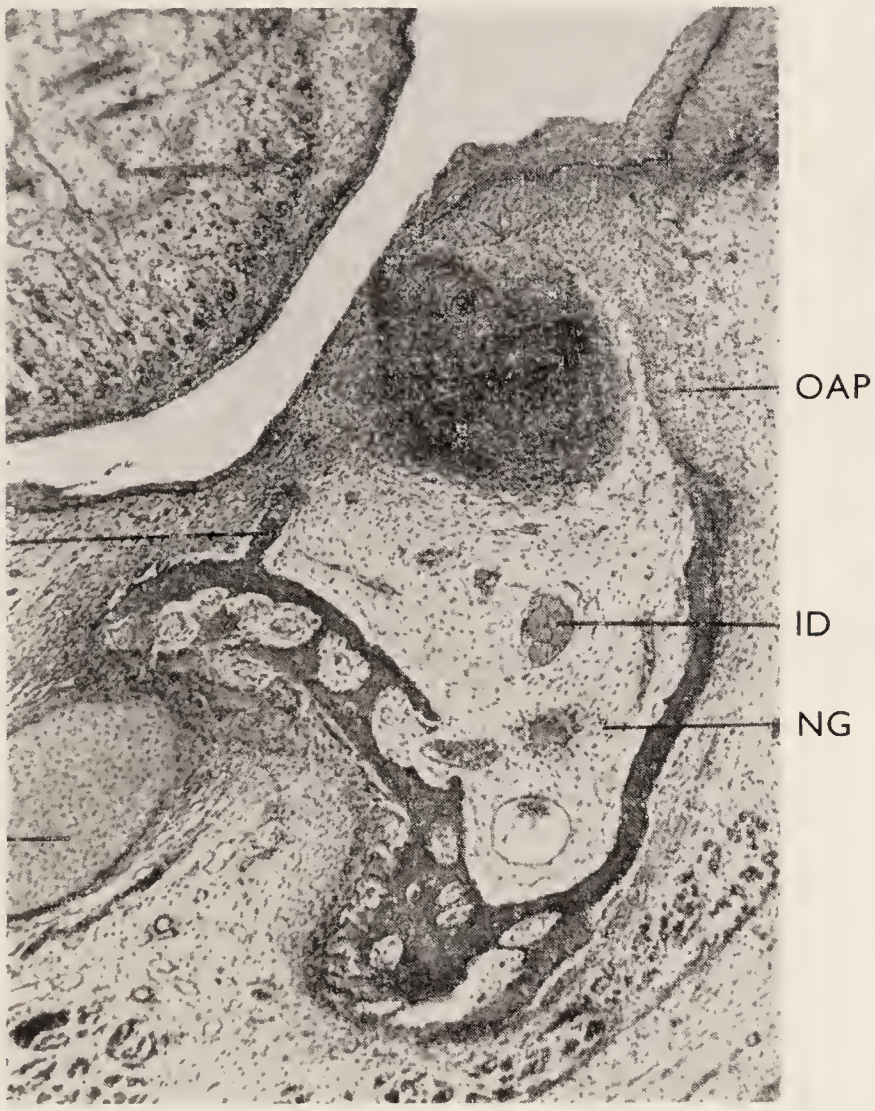

Fig. 5.—Coronal section through the mandible of a 44-mm. C.R. length human embryo. IAP, Inner alveolar plate; ID, Inferior dental nerve; MC, Meckel's cartilage; NG, Neural groove; OAP, Outer alveolar plate.

of the jaw, for it has already begun to outlive its useful purpose, which was to support the mandibular arch structures before bone development. Therefore it is soon resorbed and taken up into the substance of the mandible, by its calcification and replacement by bony tissue. This encroachment by the mandible is very active by the 75-mm. stage, beginning in the future canine region and spreading mesially and distally. *Fig.* 6 shows the irruption of osteoblastic elements into the substance of Meckel's cartilages and the changes taking place within them at the 75-mm. stage. This is a coronal section and both sides of the lower jaw are shown. As a result of the spread of resorption mesially it is possible that the most anterior part of Meckel's cartilage may remain unresorbed for a considerable period and be associated with pathological changes at the symphysis. The fate of the more posterior parts of Meckel's cartilage is well known—its contribution to

Fig. 6.—Coronal section through the anterior part of the mandibular region in a 75-mm. C.R. length human embryo showing resorption of Meckel's cartilages by mandibular bone.

the sphenomandibular ligament and two of the ear ossicles, the malleus and incus.

During subsequent mandibular development cartilage makes its appearance in other situations as a secondary phenomenon, in response to the stress of muscle attachment (in the coronoid and angular processes), the demands of growth (condylar process), or possibly local ischæmic conditions (alveolar processes).

Nodules of alveolar secondary cartilage are of frequent occurrence in the canine and incisor region, being of a hypertrophic variety, and are customarily seen in embryos of more than 100-mm. C.R. length. The coronoid cartilage appears as early as the 44-mm. stage but has disappeared by birth. This applies also to the cartilage found at the angle of the mandible and which is less pronounced, for it is less subject to muscular stress and is probably best termed "chondroid bone" rather than undoubted cartilage. The condylar cartilage extends backwards, upwards, and laterally from the region of the future inferior dental foramen to the temporomandibular

joint as a cone-shaped mass typical of that found at the growing ends of long bones. It appears between the 40–50-mm. stage but by mid-term is replaced almost entirely by bone trabeculæ, except for its base which forms the articular surface of the mandibular condyle. Continuing to function as a growth cartilage until after the twentieth year it is responsible for much of the increase in length of the mandible.

By four and a half months the adult form of the mandible has been attained. To the basal (neural) element have been added alveolar, muscular, and cartilaginous processes. The bone is of the typical embryonic woven variety with little indication of compact layers. Radiographs of a mid-term mandible (*Fig.* 7 A) reveal both the cancellous nature of the bone, the trabeculæ radiating from the region of the centre of ossification, and the remarkably cancellous appearance of the now osseous growth cartilage.

DEVELOPMENT OF THE MAXILLA

It would be an interesting finding if the centre of ossification for the major bone of the upper jaw were situated in a position comparable to that existing in the mandibular process, as described above. This is indeed the case, for the maxilla begins its development in an exactly similar fashion in a nerve angle formed in this instance by the infra-orbital nerve and its anterior superior dental branch. The maxilla appears a little later than the mandible, a natural observation when one observes that the maxillary process is an offshoot from an already well-established mandibular process, and therefore tissue differentiation within it must necessarily occur at a later stage. Sagittal sections from a 25-mm. embryo (*Fig.* 8) show the relationships of the maxillary and mandibular divisions of the trigeminal nerve to the upper and lower jaw respectively. The trigeminal ganglion is a relatively enormous structure at this period of development.

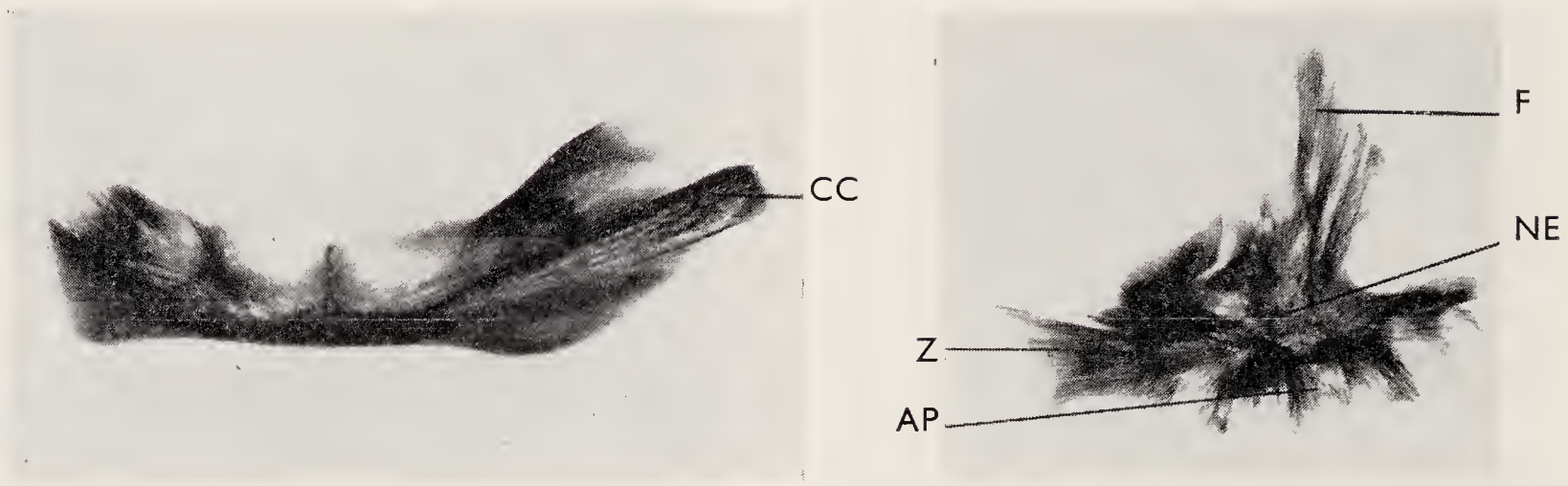

Fig. 7.—Microradiographs of the mandible (A) and maxilla (B) from a mid-term human fœtus. AP, Alveolar process; CC, Condylar cartilage (ossified); F, Frontal process; NE, Body of maxilla; Z, Zygomatic process.

The maxilla spreads rapidly from the single centre in several directions, upwards towards the cartilaginous nasal capsule as the frontal process, inwards into the substance of the now horizontal palatal folds as the palatal process, and downwards towards the outer side of the dental lamina as the outer alveolar plate. These modifications to the single centre of ossification are quite evident in embryos of 30–35-mm. C.R. length.

As in the case of the mandible the primary spread of maxillary bone is essentially to establish a neural groove which supports and contains the infra-orbital nerve. In sections from a 60-mm. embryo (*Fig.* 9) this groove is a prominent feature, its medial wall being closely related to the nasal capsule. Here, as in the mandible, the alveolar plates project from the body of the bone in response to the presence of developing tooth germs, the medial alveolar plate being a downgrowth from the root of the wedge-like palatal process.

The close relation of the maxilla to the cartilaginous skeleton of the nasal capsule is more striking in sections cut in the horizontal plane, when the bone is seen to be closely applied to the lateral surface of the capsule for the greater part of its antero-posterior length, strikingly reminiscent of entirely devoid of cartilage in its development. A small site regularly appears at the root of the zygomatic process about the 44-mm. stage, but only persists for a short time. This alternative to bone formation may be due to ischæmic conditions, as in the alveolar plates in the mandible, or to localized demands

Fig. 8.—Sagittal section from a 25-mm. C.R. length human embryo showing the relationships of the developing jaws to the divisions of the trigeminal nerve. ASD, Anterior superior dental nerve; IO, Infra-orbital nerve branches; MA, Mandible; MAX, Maxilla; MC, Meckel's cartilage; MD, Mandibular division; MX, Maxillary division; TG, Trigeminal ganglion.

Fig. 9.—Coronal section through the maxillary region in a 60-mm. C.R. length embryo. AP, Medial alveolar plate; NC, Nasal capsule; NG, Neural groove; P, Palatal process.

the conditions in the lower jaw. These observations suggest that the primary cartilaginous skeleton of the jaws and the developing teeth determines the fundamental form of the face, to be modified later by functional activity. By means of a diagram (*Fig.* 10) and a table (*Table I*) it is possible to summarize

Table I.—Structures related to the Developing Jaws

Mandible	Maxilla
Inferior dental nerve	Infra-orbital nerve
Meckel's cartilage	Nasal capsule
Tooth germs	Tooth germs

the early development of the jaws and to indicate the direct comparisons between them in their relationships to surrounding structures.

Whereas the mandible receives a major contribution from the appearance of accessory or secondary cartilages, the maxilla is almost

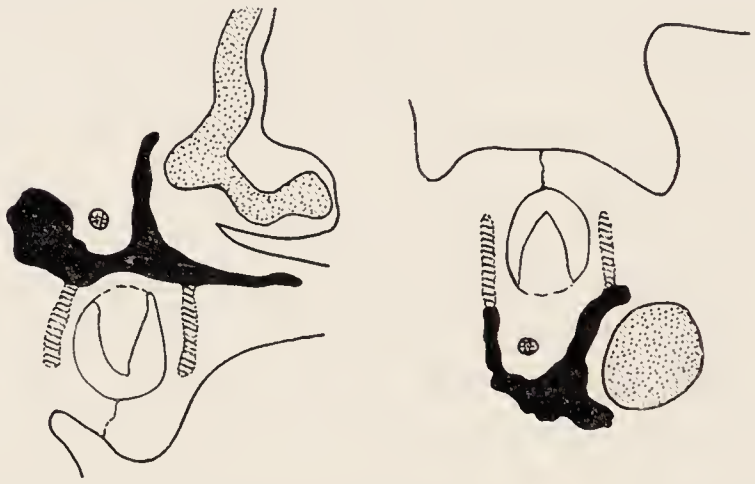

Fig. 10—Diagram comparing the developmental parts of the maxilla (on the left) and mandible. Solid black shows the neural groove; Hatching, alveolar plates; Stipple, cartilage.

for rapid growth. Although of much less importance to the subsequent development of the maxilla, the appearance of cartilage enables a further comparison of the developmental elements in both jaws to be made, again stressing the outstanding basic similarities in the early development of these bones. This is represented in tabular form (*Table II*).

Maxillæ from mid-term fœtuses are thus made up of a body, alveolar, frontal, zygomatic, and palatal processes, and radiographs

show ideally the radiation of bone trabeculæ from the centre of ossification; yet another comparison between maxillary and mandibular development (*Fig.* 7 B).

Table II.—Developmental Elements

Mandible	Maxilla
Neural	Neural
Alveolar	Alveolar
Ramal	Zygomatic
Muscular	Palatal
Cartilaginous	Cartilaginous

DEVELOPMENT OF THE PALATINE BONE AND THE PREMAXILLA

The maxilla forms the major part of the upper jaw, but is added to from behind by the palatine bone, and in front by the premaxilla.

The palatine bone, like the maxilla, develops in membrane in relation to the nasal capsule and, in this instance, to the sphenopalatine branches of the maxillary nerve. It is less striking in its development because of its lack of relationship to developing dental structures.

Of much greater interest and importance is the premaxilla, which is customarily defined as the bone of the upper jaw which carries the incisor teeth. However, considerable controversy has centred around this bone for many years, a number of authors doubting its existence in Man. This is an opportune occasion to discuss some of the evidence concerning its differentiation.

In all primates other than Man there is no doubt of the existence of the premaxilla, which remains evident throughout life on the facial aspect of the skull, a well-marked suture separating the premaxillary and maxillary elements. Thus the narial margins are formed entirely by the alveolar and frontal processes of the premaxillæ. In Man there is no evidence on the facial aspect of the skull of a premaxilla-maxillary suture, the only possible indication of its existence being on the anterior part of the hard palate where small sutures, which pass laterally towards the lateral incisor or canine tooth, are usually taken to be visual evidence of the premaxilla-maxillary junction.

It has been suggested by a number of workers including Callender (1869), Wood-Jones (1947), and Woo (1949) that in early embryonic life the maxilla grows forward over the premaxilla and by meeting the opposite maxilla (forming the "maxillary clip") the premaxilla is buried completely on the facial aspect. Hence the sockets for the incisor teeth are formed labially by the maxilla, lingually by the premaxilla, and the narial margins are of maxillary origin.

Recently an earlier contention by Frazer (1946) that the premaxilla is non-existent in Man has been revived by Jacobson (1955) based on embryological evidence. These authors maintain that the so-called palatal incisive suture is not a true suture but the remains of a bay or recess in the medial border of the palatal process of the maxilla, induced by the presence of the nasopalatine duct, associated vessels, and nerves.

The non-existence of the premaxilla would fit in well with the conception of the development of the jaws presented here, for a single unit on each side of the upper as well as the lower jaw would be even more suitable for direct developmental comparisons. However, the evidence from available embryological material is confusing. Histologically, embryos from 15–30 mm. in C.R. length support, in a number of instances, Jacobson's findings of complete bony continuity from the centre of ossification of the maxilla to the midline, with no definite evidence of separate ossific centres. Individual sections may show a slight break in continuity but when due consideration is given to serial sections this is sometimes found to be misleading. The only real evidence for distinction between maxillary and premaxillary elements seems to be the sharp line of demarcation between fully formed bone trabeculæ (maxilla) and a more recent osteoid stage (premaxilla) which is often apparent in these early embryos (*Fig.* 11). The osteoid is more palely stained than the calcified bone.

Naked-eye examination of the fœtal maxillæ suggests the existence of the premaxilla, for

on the medial aspect of the frontal process a well-defined suture-like groove passes vertically downwards towards the palate and is continuous there with a suture which terminates at the incisive foramen. The presence of a fissure of this extent is denied by those who favour the non-existence of the pre-maxilla.

Fig. 11.—Horizontal section through the maxillary region of a 25-mm. C.R. length human embryo. ASD, Anterior superior dental nerve; M, Maxilla; O, Oral cavity; PM, Premaxilla.

Then again certain abnormal skulls strongly suggest that a premaxilla is present in Man, and Derry (1938) described two adult skulls in which he suggested that this bone had failed to develop. Finally, although one must be aware of the pitfalls in relating comparative to human anatomy it seems unreasonable that the premaxilla should be a constant feature of mammalian skulls, even in the remaining members of the primates, and yet to have disappeared abruptly and entirely in Man, even allowing for his remarkable lack of dental specialization.

One of the important applications of the concept of the premaxilla is to the aetiology of cleft palate and lip. Unilateral and complete bilateral jaw–lip clefts appear to be more readily explained on the basis of lack of fusion of maxillary and frontonasal processes with consequent separation of bony elements and teeth contained within them, although the variable position of the lateral incisor to the unilateral cleft remains difficult to explain. The summation of evidence as far as one is concerned at present favours, in normal development, extremely rapid fusion of a nevertheless potentially separate maxilla and premaxilla.

Henceforth, the development of the jaws, by which process all the constituent parts of the jaws are acquired, is superseded by growth or increase in size, the one process merging imperceptibly into the other. At first all parts undergo active enlargement but soon this is limited to certain sites where growth takes place in three ways: (1) growth of cartilage and its replacement by bone; (2) surface deposition of bone; and (3) growth at sutures.

CLINICAL APPLICATIONS

The principles of jaw development may be applied to clinical dentistry and these will be dealt with briefly.

1. It has been shown that the teeth are supported by alveolar bone which develops expressly for this purpose. In orthodontic practice alterations in pressure upon teeth promote cellular modulations in the labile alveolar bone which consequently adapts itself readily to altered tooth position, a modification most easily carried out during the growing period.

On the other hand, the basic neural element develops for quite a different purpose—to support nervous tissue—and one would not expect this part of the jaws to respond to tooth movement. The critical region of dento-facial development seems therefore to lie between the alveolar bone and the basal bone which supports it.

When teeth are lost from the dental series alveolar bone no longer serves a useful function and is resorbed. This is further evidence of the distinction between the primary jaw elements and is, of course, of special importance in prosthetic dentistry.

2. A knowledge of jaw development helps to elucidate certain pathological features.

a. Cleft palates and lips have been mentioned earlier; essentially they are the result of a failure of union or secondary breakdown of embryonic soft tissue processes.

b. The most likely sites for cartilaginous tumours of the jaws can be anticipated, and agree well with clinical observations. This does not imply that fœtal cartilage necessarily

persists into adult life, but that certain cells may well retain a potentiality to produce cartilage matrix under certain circumstances. Alternatively, the close relationship of the primary cartilaginous skeleton (nasal capsule or Meckel's cartilage) to the developing jaws may be another source of cartilaginous foci, in the form of remnants of these structures.

c. The greater dependence of the mandible on growth by cartilage replacement accounts for the overgrowth of the lower jaw compared with the upper facial skeleton in acromegaly. Conversely, the dystrophy affecting membrane bones which are not dependent on cartilage replacement, namely, cleidocranial dysostosis, primarily affects the maxillary region.

SUMMARY

The early development of the jaws is described with emphasis on a comparison of their developmental patterns. It is suggested that at least two important concepts emerge from this paper.

1. The jaws should be considered as a unit in the developmental as well as in the functional sense; for beginning their existence in derivatives of the mandibular arch they are induced to develop in accordance with certain related structures which are comparable in both jaws. These are the dental nerves, cartilaginous elements, and the dental lamina and tooth germs.

2. Far from being a mere academic exercise this problem has a bearing on a number of specialized branches of clinical dentistry.

Acknowledgements.—I wish to record my thanks to Mr. P. Howarth and Mr. D. W. McKears for their assistance in the preparation of the photomicrographs and microradiographs respectively.

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DISCUSSION

Dr. W. R. Burston said that it gave him great pleasure to open the discussion on Mr. Dixon's paper which he had found quite fascinating. As the Chairman had recalled, Mr. Dixon belonged to that noble band of morphologists who sprang from that outpost of the Empire, Belfast! Everyone working in orthodontics and allied fields must be grateful that a certain number of morphologists were taking dentistry and in particular dental development under their wing. Manchester—not only students but orthodontists also—were very fortunate in having Mr. Dixon's able support.

Mr. Dixon had commenced by mentioning growth and development and his object was, of course, to circumscribe his paper and keep it within limits. He was thus using "development" in the restricted sense common to embryology, but as far as the jaws were concerned development did in fact continue long into post-natal life—a fact which made orthodontics the interesting study it was. Seriously, he thought the problem of development, extending some of Mr. Dixon's remarks a little further, permitted slightly different interpretations.

He had been very interested in what Mr. Dixon had said about the formation of the facial processes, and, in so far as the primitive palate was concerned, to what degree epithelial fusion was involved.

With the extreme shortage of cleft-palate human embyros, and for that matter a close series of normal embryos, the matter could not be regarded as settled. He himself tended to follow Streeter's view in regarding a cleft of the primary palate (harelip and alveolar cleft) as arising primarily by breakdown consequent on the failure of the mesodermal maxillary process to extend far enough towards the midline. One of the advantages of this view was that it provided an explanation—possibly too facile an explanation—of the aetiology of this kind of cleft and also explained the variability of the position of the cleft. In this context it must be remembered that the respiratory by-pass which defines the primitive palate was complete by about five weeks, whereas the ossification of the premaxillary-maxillary complex was a later phenomenon. Mr. Dixon might like to clarify these points a little further.

Neural induction was a fascinating field for the experimental embryologist. It was true of course that neural development played a vital role in the early development of the embryo. It would be recalled that modern theory now held that the facial mesoderm was derived directly from neural crest material. However, the suggestion that, at a much later stage, peripheral nerves were responsible for the induction of membrane bone was, he thought, a new suggestion and quite fascinating. Clearly the problem was difficult in amniotes because the experimental approach was fraught with technical difficulties. It was true, of course, that as far as the head was concerned membrane bone was usually found in association with a leash of nerves, e.g., parietal

and frontal bones. However, it was difficult to reconcile Mr. Dixon's thesis with the view of the classical morphologists when one thought of the phylogeny of these bones. The complex structure of the reptilian skull came to mind where it would be difficult to explain the induction of these bones on the above theory. Another difficulty arose in considering teratoma, where one found dental derivatives and undoubted membrane bone forming not in association with nerves in the way Mr. Dixon had described.

Then there was the question of the neural elements of the maxilla and mandible considered as the "basal elements" of these bones. Here care was necessary because orthodontists had introduced their own term "basal bone" with a different connotation. It was some sort of recognition that there were areas of the maxilla and mandible outside normal orthodontic procedures. Now the anatomists were using the term and ascribing to it definite landmarks.

It would appear that in orthodontic usage the region called basal bone is not constant, but increases as the jaws grow. From the practical standpoint there was in this an argument for the early correction of a malocclusion in order to avoid leaving behind an area of deformed bone which could no longer be altered.

Using the term "basal" or "neural element" in the way defined by Mr. Dixon, he was in agreement that these structures combined to form a functional unity. This was achieved by virtue of the fact that both maxilla and mandible were originally developed in close association with the primordial cartilage of the chondrocranium. Mr. Dixon had rightly made a very close comparison between the mandible and the maxilla from this standpoint.

This importance of primordial cartilage, as a spatial regulating mechanism between the jaws, was seen best in lower forms, e.g., the reptiles, where Meckel's cartilage persisted for a long time. Since this cartilage articulates with the otic capsule and hence with the cranial base (which includes the nasal septum), any growth of cartilage must influence jaw relationship.

The mammalian mandible was unique. Most people would agree that it corresponded with the dentary of the reptile. However, the interesting thing was that mammals had this unique trick of cutting off the upper end of Meckel's cartilage to form the ossicles of the ear. At that time the mandible developed its condylar cartilage and this cartilage took over the task of maintaining the spatial relationship of the jaws, and for this reason the condylar cartilage was unique amongst secondary cartilage occurring elsewhere in the jaws.

He therefore reached complete agreement with Mr. Dixon regarding the functional unity of the jaws via cartilage, but wondered how much further one could take the analogy between the two jaws. Regarding the premaxilla and the maxilla, the independence or otherwise of these bones had been a happy hunting ground for many years. Fallopius in the sixteenth century had been the first to describe the inter-canine suture of the palatal surface. The whole problem revolved round the method of examination that was employed and this was particularly true of human material. Human specimens were very difficult to obtain in good condition and in anything like a sufficiency of numbers to get a close series. One tended to employ the histological method of examination in such valuable specimens so as to have the best of all worlds. However, the trouble with these serial sections was that it was very difficult to identify bands of condensation and the margins of early bone and cartilage formation. In the early stages so much depended on the staining technique and minor variations would produce profound differences in subsequent appearance and interpretation.

The history of cranial morphology abounded in contentious argument based on such conflicting evidence, and in general the histological method was now recognized as unreliable in the identification of independent morphological units.

Very recently, in order to obtain some quick information, he had resorted to the rather out-of-date method of bulk-staining a human specimen, clearing it, and examining it *in toto* under a stereobinocular microscope. In these circumstances, although he would not claim to have made a complete identification, the appearance indicated that the premaxilla and maxilla coexisted as two independent elements.

He was very appreciative of the lecture and thanked Mr. Dixon very much.

The Chairman (*Professor Ballard*) said he would like to make one observation on which Mr. Dixon could comment if he liked. It related to cleft palates from the clinical point of view. He tended to agree with those who believed it was lack of fusion and not a breakdown. Looking at clefts radiographically, there appeared to be a quite obvious deficiency of bone. It was probably a deficiency, in early development, which resulted in failure of fusion.

In particular, one could not help noticing radiographically in the premaxilla region, that the bone which orthodontists would call the basal bone appeared to be entirely absent. In the proboscis Mr. Dixon had shown he would say that the bone was alveolar bone.

If one tried to move teeth across the cleft to stimulate bone in the root region, one failed completely and produced root resorption. That was his experience.

The paper was now open for general discussion.

Mr. J. R. E. Mills said he must congratulate Mr. Dixon on his extremely lucid exposition.

Mr. Dixon had drawn attention to the early closure of the suture between the maxilla and premaxilla in man as compared with the great apes. This was associated with another difference between the two groups; in the apes there was a large canine with a diastema between this and the lateral incisor. Growth was necessary to produce sufficient room for these two features, but corresponding growth was not necessary in man where the canine was small and there was no diastema. Was it possible that the persistent suture in the apes was associated with this increased need for growth?

Mr. Mills remembered, some years ago, examining a large series of ape skulls and his impression was that in female chimpanzees, where the canine was comparatively small, this suture closed at an early stage.

Mr. W. J. Tulley said that he had never heard so lucid an explanation of these aspects of development.

One thing that he would disagree with was the expression "abnormal growth" in one area or another. In most orthodontic cases, one was not dealing with abnormal growth in any one part but with an overall genetic pattern of growth.

The Chairman (*Professor Ballard*) said he must admit to having been shocked by the words "abnormal growth" but thought it was not for him to comment from the Chair. He supported Mr. Tulley's remark.

Mr. Dixon, in reply, thanked members for their kind remarks.

As to the words "abnormal growth", he had, of course, dropped in a few expressions like that in the hope that they would lead to discussion. There was continual discussion about what was normal and what was not normal, and he would not attempt to enter into it at all.

He agreed to a great extent with what Dr. Burston had said about the subdivision of growth and development; whether or not development was thought of as going on into adult life was really a matter of personal preference. Looking at the aspect from which he himself had treated the matter, he liked to think of development as the stage from the beginning to the time when all the bits and pieces were present. Then one went on to growth, when the bits and pieces grew in size but there was no further addition of any new element to the mandible or maxilla. Therefore, he considered development as that fairly definite stage when the "alphabet" was laid down. When the "alphabet" had been laid down one could increase the size of the letters as much as one liked—that was growth.

With regard to the development of cleft lip and palate, failure in the fusion of facial processes and the failure of the maxillary process to grow round was the usual view and one he held himself. The primitive palate was formed by the lower part of the frontonasal process, and the maxillary shelves grew in and fused with it.

The Chairman had brought out very well the point about fusion, but the difficulty was that, as Jacobson had pointed out, the bone may not hold to the boundaries of its own embryonic process. In other words, it could grow right through into a neighbouring mesodermal process and there was not a line of fusion showing at this stage. It was a difficult problem and largely due to the premature fusion of the soft tissues before the ossification centres appeared.

Some interesting remarks had been made about neural induction. If it had been possible, it would have been interesting to investigate it in animals with amniotic cavities; but one had not only to go through the uterus but through the amnion which released fluid, and the embryo frequently aborted. This was the kind of difficulty which prevented him from tackling it himself.

He had not tackled anything much lower than Man in the evolutionary scale or pattern, primarily because he thought one could not relate anything to human development that would be accurate experimentally apart from primates or something very near to primates, because of different morphological features.

Another thing which put one off experimentation, if one thought about it, was how to show that one had not just produced an abnormal result. If one damaged the connective tissues of the soft embryonic processes as well as nervous tissue the result was not necessarily due to the destruction of the nerve but to coincident damage to the surrounding area or possibly upset of the ossification process. Teratomata were extremely abnormal productions and could hardly be related to normal bone development.

He had used the term "basal bone" because he also thought of it as an orthodontic term and not particularly as a developmental one. In his own mind he related the neural element to the subsequent basal element because the basal bone was the bone that had been derived essentially from that neural element in the embryo, just as the alveolar bone in the adult was derived from the alveolar processes of the embryo. He liked to think of these elements as being clearly distinct from one another.

Dr. Burston was a tremendously keen morphologist, as members were aware, like himself to some extent. He would not go back to reptiles for reasons that were now obvious. He was specifically concerned with human development and therefore left out other forms. But he agreed entirely that the important point was that primary cartilage formed independently from the jaws. The secondary cartilage was a localized phenomenon. It meant other bony processes were to be shot out in this or that direction or that there might not be a good enough blood-supply at a particular time. It was quite subsidiary.

Histologically, there was no doubt that the premaxilla was a difficulty. It was interesting that the two separate elements could be seen under the dissecting microscope. Undoubtedly, the whole thing turned on the fact that one could not get enough of the very early embryos or if one did they were often damaged in some degree. That was a major reason for the continued controversy.

Professor Ballard's question about radiological appearances of clefts was quite new to him and he did not know very much about it. It was very interesting, for if the alveolar bone was present in the proboscis, where did it come from? Would it still be derived from the premaxillary element or an overgrowth of maxillary element, and if so how did one argue against Wood-Jones and others? How did one get over the difficulty that many people maintained that the lingual alveolus was premaxillary and the buccal maxillary? If it was alveolar bone, what bone was it derived from? It must be one or the other.

In reply to Mr. Mills, there had not been enough skulls of primates or female apes to examine to find out whether the suture was absent or not. He had never noted its absence himself but it was well worth going into.

With regard to the diastema, in many of these animals it was negligible in size. Not a great deal of diastema was present in some of them, and yet there was a very well defined premaxilla-maxillary suture. The presence of the suture did not seem to imply growth in every case.

The Chairman assured Mr. Dixon that it was not due to lack of interest that so few people had taken part in the discussion. It did members of the Society a lot of good to hear someone go over the ground that he, at any rate, should have remembered from his undergraduate days, particularly when it was put so lucidly that he could understand what he was told. It also did them a lot of good to have these new views put forward, particularly if they seemed to support clinical observations. He had pleasure in thanking Mr. Dixon and also Dr. Burston for opening the discussion.

SOME SURGICAL PROCEDURES RELATED TO ORTHODONTIC TREATMENT

By J. H. HOVELL, M.R.C.S., F.D.S., D.Orth. R.C.S.

In dealing with surgery in relation to orthodontic treatment, there are two main eategories to be considered. First, there is surgery which is needed to allow the eorreetion of loeal abnormalities of position. Secondly, there is surgery for the correction of extreme variations of the skeletal pattern. These extreme variations produce malocclusions whieh are not treatable by normal orthodontic methods, for example, the gross Angle's Class III ease.

There is one prineiple whieh is eommon to both categories—this is that full diagnosis and treatment planning, to inelude any preliminary orthodontie work, must preeede surgery. However teehnically perfect the surgery, it is likely to fail if diagnosis and treatment planning have been faulty. Providing the ultimate aim is achieved, the aetual technique by which it is reaehed is quite unimportant. It is really immaterial providing first principles of surgery are observed, whether, for example, bone is removed by burs, hand gouges, or chisels. The most important first principles are asepsis, adequate aeeess, and firm but gentle handling of tissues with no avoidable trauma. Asepsis is, of eourse, unobtainable in the mouth, but this does not mean that it should be ignored. Cold surgery in the mouth should never be undertaken in the presence of acute gingival inflammation or in a post eoryzal period when a mixed infection of the nasopharyngeal mueosa is likely to be present. In addition, full aseptic preeautions should be taken to prevent eontamination by pathogenie baeteria not already present in the mouth.

With regard to the routine administration of antibiotics in eold surgery in whieh infeetion is likely to supervene, there have always been two schools of thought. Apart from a short period in the early days of antibiotics I have always eonsidered this to be of no value whatsoever. Surgical opinion is now swinging even further in this direetion in considering that it may even be harmful. Antibiotic resistant strains of organisms may arise or be permitted freer development by the absenee of other inhibiting organisms. A post-operative infection with these organisms is often most diffieult to eontrol and an extremely serious eomplication. Local application of penicillin powder or cones in the absence of parenteral administration is not merely useless but may be even more aetively harmful. Individual sensitization to penicillin is more likely to arise from these small doses, and in my opinion the loeal use of penicillin cones, powder, and lozenges without coneurrent maintenance of an adequate blood-level is an indefensible procedure. Penicillin is far too valuable a live-saving drug to be frittered away, and for a patient to become allergie to it and be denied its use in, shall we say, pneumonia or endocarditis, is an absolute tragedy.

Fortunately, in the first category of cases the surgery is of a minor nature and ehildren's mouths are, or ean readily be made, very elean. In addition, wounds in or around the mouth and faee, with few exceptions, heal readily with a minimum of seeondary infeetion. In the second eategory, even if the surgery is not carried out eompletely extra-orally, infeetion seldom supervenes if pre-operative elimination of oral sepsis and the employment of a full aseptic technique are carried out.

The conditions in my first eategory with whieh I will deal are as follows:—

1. Frænectomy;
2. Removal of supernumeraries;
3. Removal of buried teeth;
4. Uneovering unerupted teeth.

It will be noted that in this list I have not included the removal of lower third molar germs or unerupted more fully developed third molars. The removal of third molar germs before ealeification commenees is a very

Given at the meeting held on March 10, 1958.

simple procedure, easily carried out under local anæsthesia. C. Bowdler Henry introduced this operation and I first performed it as his house surgeon in 1934, since when I have done many cases—very, very few recently, however. I think that if we can develop adequate criteria for assessing between the ages of 7–12 years the likelihood of future third molar impaction, this operation may well be a clinically desirable undertaking. It should be noted that this operation is only simple up to the time the calcifying cusps commence to unite. After this it becomes much more difficult and should not be done under local anæsthesia. The reason for its omission is that I consider that from the point of view of orthodontic treatment removal of third molars is valueless. Arising on the surface, the third molar germ sinks into the body of the bone and does not appear in the dento-alveolar part of the jaw which concerns orthodontists until well after the normal age for orthodontic treatment is past.

There are two possible ill-effects upon the occlusion which may be produced by the third molar teeth: one is relapse of previously undertaken orthodontic treatment and the other is forward drift of buccal segments with late imbrication in the labial segments.

The effect is often, I think, due to incorrect initial diagnosis, and treatment without extraction in cases in which extraction was necessary in order to obtain a stable result. The imbrication of lower incisors, subsequent to intermaxillary traction, was also often wrongly attributed in the past to pressure from third molars.

Late imbrication of labial segments is undoubtedly due in many cases to a maturation change in soft tissue relative to skeletal morphology, producing an uprighting of the incisor teeth.

As far as I am aware there has not yet been produced a statistically valid assessment of lateral radiographs to show whether or not erupting third molars can produce a forward drift of buccal segments.

It is my opinion, from clinical observation, that this does occur, especially in the upper arch. Clinical observation, however, must be substantiated by scientific proof to be of real value, and I am therefore perfectly prepared to eat my words if necessary. I should very much like to hear observations from other members on this point.

In the immediate post-war period I passed through a phase during which in my clinical assessment of cases I decided that extraction of lower third molars whose crowns were fully formed was a correct adjunct to orthodontic treatment. This was usually about the age of 14 or 15. These teeth were always deeply buried in the body of the mandible. Other members of the orthodontic staff or consultants frequently asked me to do these teeth for them.

Some weeks or months later a case would appear in the theatre for removal of third molars. After an hour's exhausting work, having inquired "What moron suggested subjecting a child to all this?" and being told it was myself, I quickly revised my views as to the desirability of carrying out this particular operation. Taking as a criterion whether or not I would advise my own child to have this non-essential operation, the answer is "not under any circumstances". Removal of third molars at this stage of development is far more difficult and traumatic than either earlier or later, even should they become impacted. Post-operative pain or swelling is frequently severe. For these reasons, added to its doubtful orthodontic value, this is a completely unjustifiable proeedure.

It may appear to many of you that I have not so far given the sort of paper which its title leads you to expect. However, it is my firm conviction that the actual techniques of dentistry should be by far the least important part of our professional skill. In fact, many of the more mechanical procedures should rightly be deputed to ancillaries. While I am not suggesting that surgery should be carried out by theatre orderlies, it is nevertheless only a technique—a mixture of carpentry and needlework carried out in a confined space, often with poor visibility on a living subject. I wish to stress, therefore, the primary importance of diagnosis whenever the use of surgery is considered.

FRÆNECTOMY

The controversy still rages as to whether the persistent frænum is in fact the cause of separation of upper central incisors. Regretfully I must decline this challenge and confine myself to a statement of fact. That is, that in properly selected cases in which the operation is properly performed, natural closure of the median diastema will often occur. The main indication is that spacing should be present in spite of the presence of factors which should tend to close it. When erupting laterals have failed to close a normal median diastema, but have instead become, through lack of space, rotated and misplaced themselves, a frænectomy is definitely indicated. I have never myself seen a median diastema without the frænum passing between the incisors to be attached palatally, nor do I consider that the actual form and consistency of the frænum is of great importance.

In cases in which a median diastema is present due to missing or small laterals, or generally small teeth in a large arch, the prognosis for natural closure is not so good. When, however, spacing is entirely midline, all other teeth being in contact, the diastema may close partially with a distribution of the spacing between other teeth and a great improvement in the appearance.

Providing the operation is not carried out as a "smash and grab" procedure under nitrous oxide anæsthesia, actual technique is unimportant with one exception. This is, that the excision should not be confined only to the soft tissues. It is absolutely essential that in addition fibrous tissue and bone in the midline between the teeth should be removed almost to their apices, and as widely as possible without exposing tooth root. I do this with a fissure bur under water-jet. I have now operated upon quite a number of cases in which removal of soft tissue alone has produced no improvement, but subsequent more complete midline excision has resulted in natural space closure.

Although the lip mucosa is carefully closed I do not consider that it is necessary to swing mucosal flaps to cover exposed bony areas. When the frænum is abnormally wide it may be difficult to approximate the mucosal edges. To facilitate this, vertical incisions are made about $\frac{1}{3}$ in. laterally on each side of the midline to allow mesial sliding of the mucosa.

REMOVAL OF SUPERNUMERARIES

A complete orthodontic diagnosis must first be made, so that any extractions required as part of the treatment plan can be done at the same time. The age-group for this operation is usually from 8 to 12 years, and in all but the easiest cases general anæsthesia is preferable. It is, therefore, doubly annoying if a general surgeon removes the supernumeraries and the orthodontist finds a few weeks later that extraction of premolars possibly unerupted is at once necessary.

This is even more important when the supernumeraries have obstructed and prevented eruption of one or more incisor teeth, usually centrals. Frequently in such cases there has been forward drift of buccal segments with loss of space in the labial segments.

For such buried teeth to erupt with certainty certain principles must be strictly adhered to:—

1. Their crowns must be uncovered.
2. If at all deeply buried, a pack must be stitched in at the time of operation and a bung added to a previously constructed plate to keep the opening patent while the teeth are erupting.
3. There must be room in the arches for the teeth.

Non-observance of any of these principles may lead to non-eruption of the incisors. Their crowns then become bound up in a mass of fibrous scar-tissue, which not only effectively prevents any further eruption, but also makes much more difficult their subsequent exposure and bringing into position by means of pinning or banding, which now become unavoidable.

It is essential that a plate be made pre-operatively. It is desirable that space in the arch should be created pre-operatively. This may involve extractions, however, and therefore for this reason, and also because the sooner after the age of 7–8 years that supernumeraries are removed the better, space

creation can be done in conjunction with the other post-operative treatment.

Localization of the supernumeraries is obviously of importance. Personally I find three intra-oral films, with different angles of incidence of the beam, quite adequate. More views are preferred by some operators, but it should be borne in mind in this connexion that radiation, especially in children, should be kept to a reasonable minimum.

The operative approach in the majority of cases is from the palatal aspect. The incision is along the gingival trough extending between the mesiopalatal aspects of the two first permanent molars. This permits backward reflection of the entire anterior portion of the hard palate.

There is absolutely no justification for making this incision 2 or 3 mm. distant from the cervical margins of the teeth. Not only does this leave a scruffy, narrow fringe of mucosa, which may slough away in parts, but it impedes vision just where this is most important—close to the roots of the incisor teeth, damage to which must be carefully avoided during the operation.

No special difficulty arises with the completely palatally placed supernumerary, nor with the more superficial, preventing eruption of more deeply placed teeth. The really tricky tooth is the inverted long, thin one lying buried directly between the roots of the central incisors. It may be found extremely tricky to "winkle out" such a tooth without damaging those adjacent to it. A dodge I often use is to make a second approach from the labial sulcus; the crown being exposed from this aspect it is quite simple to push the tooth through to the palatal side, rather in the same way that a nail is knocked out of a piece of wood.

One midline mattress suture is used to secure the flap. The only occasion upon which a hæmatoma formed below the flap and raised it was when several sutures were used. Healing is rapid, and strangely enough there is little or no post-operative discomfort.

REMOVAL OF BURIED TEETH

In my opinion buried teeth which are giving no trouble are best left buried. They may erupt and then are much more easily removed, or on the other hand remain trouble free until pressure from a denture stirs them up. If, however, the tooth is in communication with the surface, i.e., has a sinus leading down to it, it should always be extracted. It may also be preventing correct alinement of erupted teeth, and for this reason have to be removed.

Resorption of adjacent teeth by a completely buried tooth, e.g., an upper canine, in my experience always occurs during the eruptive phase of the tooth, and is an aberration of the normal resorption of the deciduous teeth during the eruption of their successors. This resorption commences very early, and I have seen a lateral incisor root completely resorbed by the age of 11 years. On the other hand, I have never seen a case in which resorption in connexion with such a tooth has commenced after it has become fully impacted, other than in connexion with an intra-oral sinus and infection.

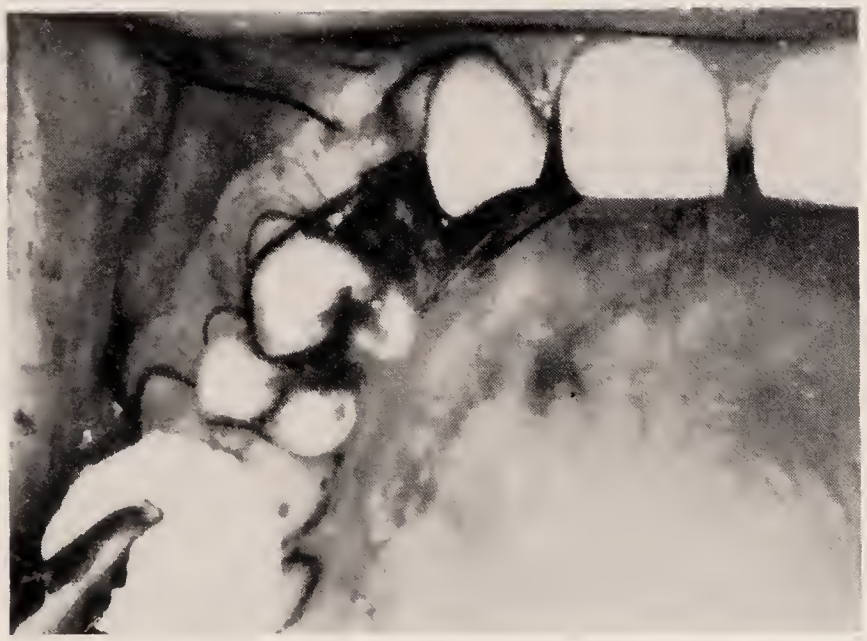
If a canine causing resorption is exposed and brought down into position, the resorption ceases and there is no apparent damage to the resorbed tooth other than loss of part of its root. I find this rather surprising, but it has proved to be the rule in every case in which orthodontic considerations ruled out extraction of either the resorbed tooth or the canine, and the latter was therefore brought into position.

One valuable point to remember is that when the crown of a buried tooth is on the labial or buccal aspect of the arch, the root is on the lingual or palatal, and vice versa. This enables the same dodge to be used to prevent damage to adjacent teeth as with the inverted midline supernumerary. It is particularly valuable with the upper canine which has become palatally impacted. The apex of this tooth is invariably situated fairly superficially on the buccal aspect somewhat higher and more distal to its normal position. Adequate bone removal palatally is difficult without damage to adjacent teeth and it therefore becomes necessary to split off the crown as a first step in its removal. Using Warwick James or similar elevators it may then be possible gently to "winkle out" the root.

Occasionally, even when there is no apical dilaceration, this attempt may fail, and only too often I have seen cases in which irreparable damage has been done to lateral incisor or first premolar. This is quite unnecessary. An incision is made fairly high in the buccal sulcus and the apex exposed, working carefully from before backwards above the level of the first premolar apex. The apex is then split off or removed with a bur as in an apicectomy, and the middle third of the tooth pushed out through the palate. The antral lining may be exposed in this way, but this does not matter as long as the apex is not pushed into the antrum.

A

B



C

D

Fig. 1.—Exposure of palatal canine. A, Radiograph; B, Removal of area of palatal mucosa; C, Insertion of pack (*N.B.*—A mattress suture is first inserted and looped out of the way around the adjacent teeth); D, Pack in position.

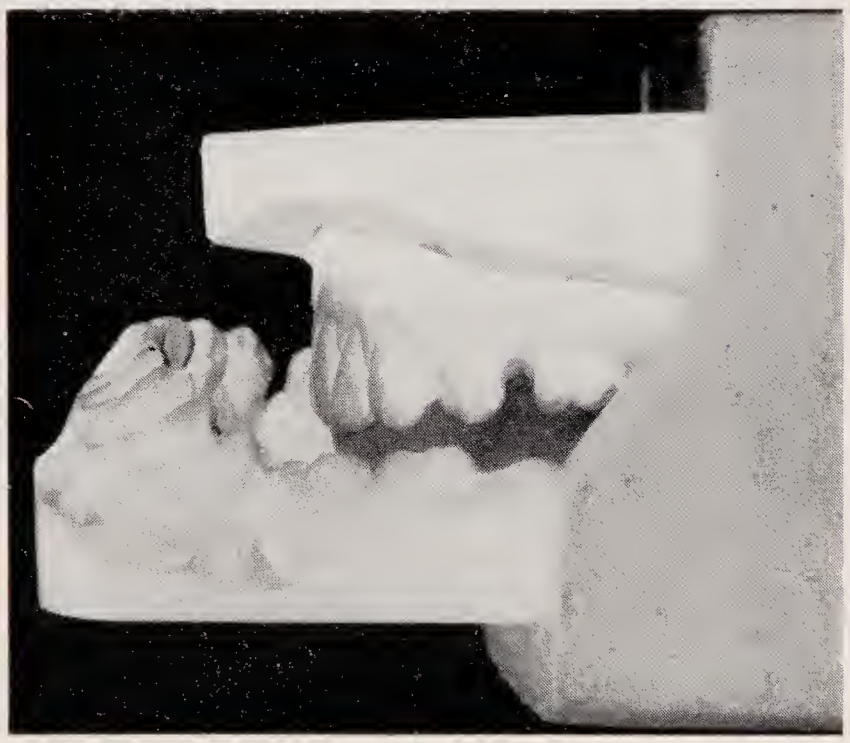
UNCOVERING UNERUPTED TEETH

The tooth most commonly requiring this procedure is the palatally misplaced canine. In my personal experience success even in apparently very difficult cases is invariable, and resort to pinning, banding, or putting wires round the teeth or acrylic caps on them, is never necessary. In this connexion it is only fair to add that the less the displacement the more likely is it to be orthodontically desirable to bring the tooth into the arch. The very high almost horizontal tooth is usually better left where it is. The best time to deal with these teeth is at the age when they would normally be erupting, and certain basic principles must be adhered to if they are to be easily brought into position. These principles are as follows:—

1. There must be space in the arch for the tooth. This must either be created by

orthodontic treatment or by extraction, usually of the first premolar at the time of operation. To expose the tooth "to see whether it will erupt" before deciding upon extraction is the

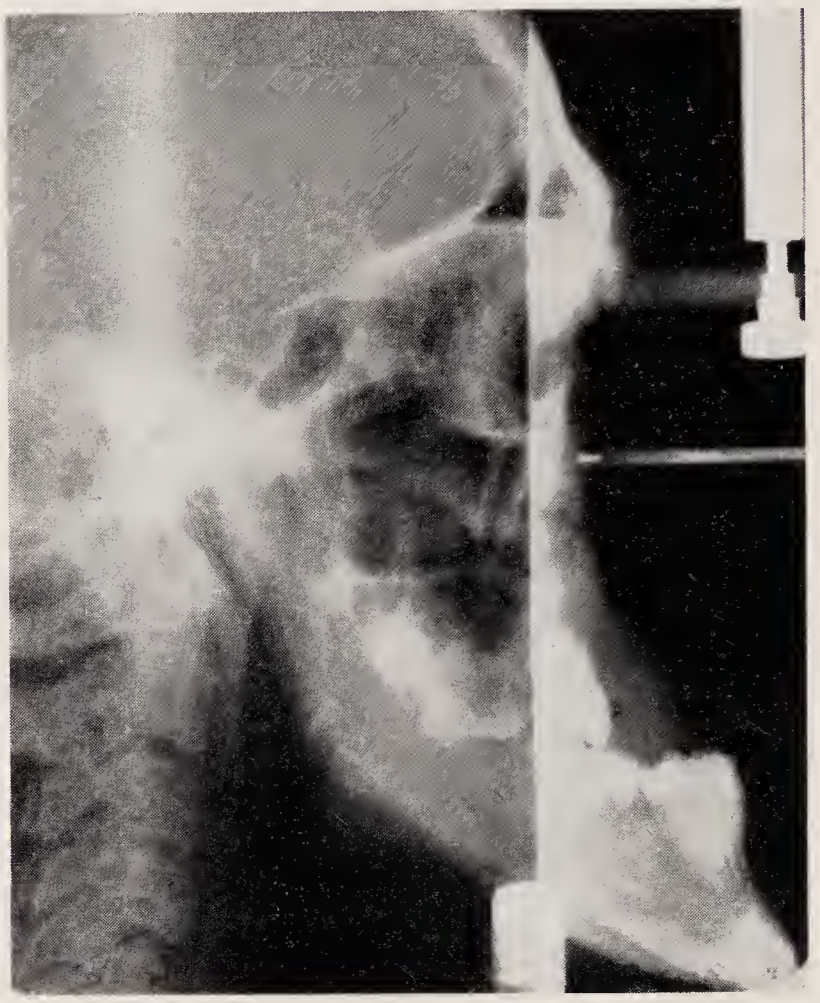
A



C

height of futility. The usual fate of such teeth is that they fail to erupt, become infected, and are subsequently removed. In this connexion it should be noted that not only does removal of the first premolar as it were clear the way for the necessary change in axial inclination of the canine, but it also facilitates adequate surgical exposure.

2. The exposure must be adequate. A piece of mucosa, midway in size between a shilling and a sixpence, should be removed. The palatal aspect of the crown must then be uncovered



B

Fig. 2.—Pre-operative appearance of a severe case of mandibular prognathism. A, Photograph; B, Lateral radiograph; C, Models.

up to at least the extent of the clinical crown, special care being taken completely to free the tip. Rose-head burs are used to remove bone without damage to adjacent teeth, and it is taken away as freely as possible in the direction, i.e., distolabial, in which it is desired that the crown shall move. If the deciduous canine and/or first premolar are extracted, their sockets should be made completely continuous with the crypt around the canine crown, by removal of all bone in between and some septal and interradicular bone, avoiding, however, any encroachment on the labial plate.

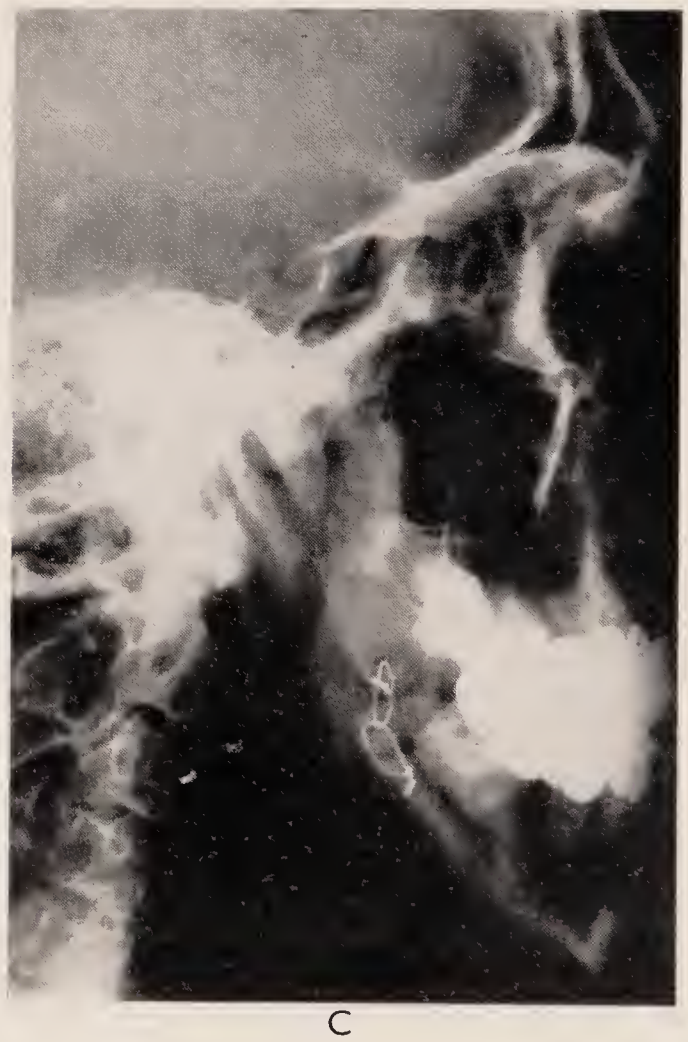
3. The exposure must be maintained continuously during the post-operative and eruptive period.

This is done by a pack, stitched in at operation, and a bung added to a prefabricated plate when the pack is removed 7–10 days later. There must be a minimal interval between removal of the pack and insertion of the bung.

For this reason the plate should be made and worn some weeks before operation, and an impression taken of the cavity on the plate and immediately processed in cold cure acrylic,

A

B



C

Fig. 3.—Post-operative results. A, Photograph; B, Model; C, Lateral radiograph.

so that the bung can be inserted within the hour.

4. The bung must be frequently and correctly trimmed in the direction in which the tooth is desired to erupt, but in such a way that the tissues are not allowed to close over the tooth. This is, in fact, a sort of hollowing-out process to accommodate the crown as it surfaces. Trimming should be at least once a fortnight, as otherwise scar-tissue has a chance to form around the tooth and prevent its eruption.

I have seen many cases in which exposed palatal canines have failed to erupt without being pulled. This failure has always been traceable to non-observance of one of these four basic principles. There is a lot to be said for an orthodontist also being an oral surgeon!

The buccally impacted canine (*Fig.* 1) is quite different for several reasons. First, it is almost invariably much higher and more horizontal. Secondly, adequate exposure without damage to the lateral incisor is difficult, if not impossible. Thirdly, and to my mind most important, the crown is above the reflection of the mucous membrane. It is, therefore, quite impossible to keep the exposure patent with a bung, as the tooth becomes so firmly fixed in position by dense scar-tissue that it is often impossible to bring it into the arch with traction.

[At this point short films of a frænectomy and removal of a supernumerary were shown.]

The second category of case, i.e., correction of extreme variations of the skeletal pattern, merits a full-length paper on its own. I will, however, show you what can be done by the following slides of a case of mandibular prognathism I recently treated.

The prognathism was so severe that the lower third molars just occluded with the incisors during lateral excursions. An angle resection was carried out, as it was necessary to reduce the length of both body and ramus, a little over an inch of bone being removed. The approach was entirely extra-oral and iliac crest bone-chips were used to hasten union. A corresponding wedge of skin subcutaneous tissue and platysma were excised to eliminate the double chin which would otherwise have resulted. The post-operative course was uncomplicated and complete union achieved in good position.

Figs. 2 and 3 show the radiographs, photographs, and models of this case.

I must ask you to forgive me for much that has been left unsaid, or perhaps over-compressed. I shall, however, do my best to reply to any questions you may put, with the President's permission, replying to each at the time, rather than all at once at the end.

Acknowledgements.—I would like to acknowledge the help I have received from the Photographic Departments of the Royal Dental Hospital and St. Thomas's Hospital, and my debt to my early teachers at the Royal Dental Hospital, especially C. Bowdler Henry and S. A. Riddett.

DISCUSSION

Mr. G. L. Fordyce, in opening the discussion, said that Mr. Hovell had a manner of presentation, a freedom of expression, and a quality of thought which were all his own.

He wished to congratulate Mr. Hovell on an excellent and clear exposition of his subject. Only once did Mr. Hovell allow his schizophrenic professional existence to overtake him and elevate himself from his surgical to full orthodontic status when he made the statement "Late imbrication of labial segments is undoubtedly due, in many cases, to a maturation change in soft tissue, relative to skeletal morphology", etc. He understood that what Mr. Hovell felt was that irregularity of incisor teeth might be caused by an alteration in lip musculature relative to the teeth and jaws or, it being very colloquially translated, crowded teeth might be caused by changes in the lips as one grew older. If he might roughly translate H.R.H. The Duke of Edinburgh, "Let them keep science simple".

Mr. Hovell had invited discussion on the influence the third molar teeth might or might not have on the forward drift of buccal segments and imbrication of labial segments, and had suggested that third molars could produce a forward drift of buccal segments. It was, however, true that buccal segments would drift forward whether third molars were present or not. Mr. Hovell had said that in many cases the irregularity was due to changes in the lip behaviour. If the first premolar teeth were absent the imbrication would not occur. There must, therefore, be a constant forward pressure which disallowed the dissipation of the increased lip pressure throughout the buccal segments.

He wished to bring to the notice of the meeting a point made by Mr. Hovell, with which he concurred, on the subject of supernumerary teeth. Mr. Hovell had said: "The sooner supernumerary teeth are removed the better". That was not, as one might think, in agreement with general teaching as expressed in standard text-books. The view expressed there was that supernumeraries should not be removed until such time as the permanent teeth had fully formed. Perhaps other views might be expressed on that subject.

He noted that Mr. Hovell had made no mention of the operation known as transplantation of teeth. Perhaps Mr. Hovell felt that such-like party tricks should be reserved for the very, very rare case. That subject also might be discussed.

Mr. Fordyce then showed four slides.

The frænectomy technique which he employed differed from that of Mr. Hovell and his slides might be of interest to the meeting. He agreed fully with Mr. Hovell that the detail was not of importance in treating the soft tissue. The essential feature was the division between the roots of the teeth, as described most adequately by Mr. Hovell.

On the subject of osteotomy, the surgical correction of mandibular deformities, and, for that matter, maxillary deformities, raised points of great orthodontic interest. Mr. Hovell had mentioned some of these.

In his experience the assessment of prognathism by the use of radiographic surveys had been disappointing. The measurements of S.N.A. and S.N.B. angles, one would imagine, would be of assistance in assessing prognathism, and would be expected to indicate the case in which the upper jaw was under-developed rather than the lower jaw being over-developed. He had not found those angles reliable.

The follow-up examination of osteotomy cases brought a point worthy of mention to an orthodontist. It was found that in cases where severe mandibular prognathism had been corrected expansion of the lower arch occurred and that the lower incisor teeth became erect. That expansion could be in the region of 5, 6, or even 7 mm. The point of interest was that no such expansion occurred

in the maxillary arch. That enhanced the view which some held that the tongue exerted little influence on the shape of the maxillary arch.

Mr. Fordyce showed sixteen slides of cases.

He expressed thanks for having been asked to open the discussion. He trusted that what he had said would precipitate a discussion of Mr. Hovell's paper.

Mr. Hovell, in reply, said that Mr. Fordyce had spent a lot of time in the orthodontic team of the Royal Dental Hospital for some years past.

With regard to the remarks of Mr. Fordyce about buccal segments drifting forward before third molars were present, when second molars were pushing them forward, most of the cases that he dealt with occurred long before the third molars were present.

He had not dealt with transplantation, which was not his subject, and it was still in an experimental stage.

With regard to the frænum, he had said that provided the final result was achieved the actual technique did not matter. There were, however, certain principles to which one had to adhere.

Mr. Fordyce had raised an issue on the subject of the widening of the lower arch subsequent to a mandibular osteotomy and said that the tongue affected the lower arch and not the upper arch. That was exactly what one would have expected to happen. When one had an abnormality of skeletal patterning, the effect of soft-tissue morphology was that in the vast majority of cases the teeth were found to be tilted out as far as they would go and the tongue did not reach up to them but was underneath them. When the mandible was set back and the tongue was compressed in a smaller space, it could not tilt the upper teeth any more, but the lower teeth, now freed from the restraining effects of the soft tissues, were pushed out into a more normal position, both buccal segments and labial segments, which was as would be expected.

He thanked Mr. Fordyce for opening the discussion and for his very kind remarks.

Mr. G. C. Dickson said that a large proportion of the supernumerary teeth in the incisor regions that one saw were placed palatal to the central incisors. He wondered whether Mr. Hovell found that it was a small point in the operative technique that it was usually more comfortable for the patient if the supernumerary was removed via a palatal approach instead of using a cross-palatal approach and exposing the unerupted incisors labially. He suggested that the other method would avoid the discomfort of a rather sore palate.

Mr. Hovell, in reply, said that if the time for the eruption of the centrals had not yet occurred all one had to do was to remove the supernumeraries. If the centrals were superficial and there was a space for them in the arch, one should remove the supernumeraries and the centrals would come through.

He preferred to do the whole operation in one. He did not find that the exposure of the centrals gave the patient any greater discomfort. They were exposed not via the palate but from the labial side. He had not found that post-operatively the patient had a lot of discomfort.

Mr. J. F. Pilbeam asked Mr. Hovell how in the body mandibular osteotomy he tucked in the neurovascular bundle. He asked whether he cut a groove.

Mr. Hovell said that he did not cut it but let it go where it wanted to be.

Mr. Pilbeam said that one thing had not been emphasized, and that was that one wanted the right type of patient. He had been interested recently to read a series of statistics published by Hoogman in America. The American had examined 171 cases which had been operated on during a period of 2–18 years, involving bilateral horizontal osteotomies and osteotomies to the vertical mandibular ramus. The summary of results showed that in 23·5 per cent of the cases there was unsatisfactory occlusion, 8·8 per cent had T.N. joint trouble sometimes, 38 per cent had facial nerve damage, and 38 per cent had inferior dental nerve damage. The extraordinary thing about those depressing statistics was that out of the total of 171 cases 97 per cent of the patients were perfectly satisfied with the operation and the treatment they had had.

Mr. Hovell, in reply, said that that was an astonishing fact. It was true that however disappointed he was with the results of a case he had yet to have a patient who was not pleased.

Mr. H. L. Leech asked Mr. Hovell what he considered to be the optimum age for body resection for mandibular prognathism. He wondered whether Mr. Hovell found that if he operated too soon in such cases he got any form of relapse.

Mr. Hovell, in reply, said that, with regard to the optimum age, he would say any age after mandibular growth had ceased.

He had not done a body resection upon a growing child for the simple reason that there was not usually enough body, even in a Class III case.

He had done an ascending ramus section on a child of 12 years. It had united and given a perfect result. Within two years the child was back where she would have been if he had never operated on her. In other words, the inherent skeletal pattern of the patient had re-established itself. That was only one case. He was not prepared to carry on experimenting with a lot more cases to see if it happened every time because the child aged 12, a Class III case, as she would have been if he had not treated her until 14 years of age, was now aged 21 and had had a body resection and was now no longer a Class III case.

Mr. C. Bowdler Henry said that he would be a very ungracious father if he did not feel paternal pride in Mr. Hovell, especially after what he had said about being his house surgeon and the tribute he had paid to his efforts to interest him in oral surgery. He had been along to St. Thomas's to see Mr. Hovell do one of the body osteotomies. Mr. Hovell had referred to the days before antibiotics when they depended on absolute cleanliness, asepsis, for the success of their operation. That was something which they achieved in those days, and it was something which he remembered with gratitude especially to those house surgeons who so diligently cleaned up the patients' mouths before the operations.

He recalled a case where a patient had had what he presumed to be a body osteotomy. She had had a very wide incision. She had certainly got her chin in relation to her maxillary in a good position, but now the woman, with no mandibular protuberance, had her chin right back in an almost straight line from the lower incisor apices down to her neck. At the same time she had an enormous balloon of cheek which he understood had already had one face-lift to try to get rid of it. In the meantime her very large tongue was pushing her lower incisors forward so that she was now getting a prognathism of her lower incisors which were almost in Class III relationship to her upper incisors. All surgeons who treated such cases should pool their information about successes so that they could learn what things to avoid.

It seemed to him that the patient to which he had referred had such a large tongue that instead of necessarily laterally expanding her lower arch she was also pushing the incisors forward. He thought in terms of some such cases of taking out a segment of the tongue as well as reducing the size of the jaw. He did not say that facetiously; he meant it literally.

Mr. Hovell had not referred to transplantation, and Mr. Fordyce had expressed regret that he had not donc so. He did not know who else had been doing transplantations besides himself. They were, frankly, experimcntal. He hoped he might have the opportunity sometime of showing members the results of cases—he had shown some at the Royal Society of Medicine, but he now had some more—in which he had transplanted some developed teeth.

He felt that Mr. Hovell was guilty of an omission in not referring to the value—perhaps he had not had time—of the new apparatus at the Royal Hospital, the rotagraph for gauging the right position in height of supernumerary and buried teeth. The machine gave a panoramic view of the whole mandible in one stretch, which was of exceeding value, especially in relation to the supernumerary, because they were difficult to assess precisely, espccially when obliquely placed, particularly with respect to vertical height in relation to the apices.

He showed a slide relating to the enucleation of the third molars in their erupting stage.

Mr. Hovell, in reply, thanked Mr. Bowdler Henry for his remarks. He said that he had not dealt with the diagnostic criteria for various types of operation, but there were cases where body osteotomy was wrong.

He had had one case in which he had done a body osteotomy on a spastic boy who had no occlusion and could not eat. The boy had a very severe mandibular dento-alveolar prognathism. He set back the boy's mandible, and he finished up rather like the case Mr. Henry had mentioned with little chin, and he had had to restore the chin.

With regard to the squareness of the face, he thought that that was a result which some people obtained in such cases by not tipping the posterior fragment. It was recommended that it should not be tipped in, but he did not agree with that. If one did not do it one got the horribly square face. He had not had any patients who had had discomfort through the tipping in.

He had been interested in Mr. Henry's radiographs of results of the enucleation of tooth germs, particularly the one where the seven was obviously drifting distally. It looked as if he had to eat his words when he said that a third molar did not have any effect on the teeth in front of it.

Mr. H. E. Wilson said that Mr. Hovell's frænectomy cases seemed to be done about the age of 8 or 9 or even 10 at the most. So far he had never yet found it necessary to recommend frænectomy. However, sometimes, where very late, he had found the frænum almost appearing to come away from between the teeth. Some people in America went to the opposite extreme and forcibly brought the teeth together, and they said that that caused strangulation of the frænum and it disappeared.

He had had an interesting case which helped to settle the matter in his own mind. It was that of a child wherc there was obviously a need for the extraction of two premolars, and that was done. At the next visit, there was a huge gap between the two incisors. It was only then that he noticed the frænum. It was a vcry large one, part of which had gone between the two teeth originally in contact. He did not know what to do, and he did nothing. The patient was now coming back to normal again. Instead of the two segments being separated in the middle, they were now behaving as a normal case, and thc diastema was now closing. So even at that stage it had had an effect in separating the two segments. Later on the frænum seemed to be coming out between the teeth, and was not, therefore, influencing the spacing of the incisors.

Therefore, would not Mr. Hovell delay doing the frænectomies until a later age when the permanent dentitions were fully developed and there was a greater degree of certainty as to whether the operation would be necessary or not?

Mr. Hovell, in reply, said that, as he had stated in his paper, he removed the frænum only when factors were present which would normally cause the teeth to close. When the lateral incisors were erupting and there was a space between the central incisors, if they became rotated and the space did not close, it was an indication for removing the frænum. If they were erupting in alinement, he would wait until the canines came through. He took it out only when there was an abnormality elsewhere in the arch produced by the persistence of the space.

He could not say that he had had such a happy result as Mr. Wilson had had of a frænum disappearing unless there had been a reason, such as the eruption of laterals or canines. If it did not close when the teeth were erupting, if they were excluded or misplaced, it was one's indication for the removal of the frænum. He had had the experience of teeth spacing most regularly after the taking out of the first premolars.

Mr. Lindo Levien, who said that he was rather mechanically minded, stated that he had not seen in the slide how the jaw was drawn together after the section of bone was removed.

Mr. Hovell, in reply, said that he wired the lower borders through the holes. The two sections were drawn together, and they were splinted in the pre-determined position by an intermaxillary fixation of the three segments and the upper splint, and a localizing device was used across the fracture line on each half of the splint.

The President said that not everyone agreed with everything that Mr. Hovell said on all occasions—even Mr. Hovell said that he himself had to eat his own words occasionally—but he was sure that no one could listen to Mr. Hovell without being impressed by his integrity and his courage and no one could go away after listening to one of his papers without being stimulated. The lecture that night had been no exception, and the size of the audience which had come to listen to Mr. Hovell was its own tribute.

Many of them during the course of their duty had to call on oral surgeons for various procedures, and it was much more pleasant for the patient and much more satisfying to them when they could call on someone who was expert in that branch, knowing that everything would be done to perfection with the minimum of disturbance both to the patient and to the patient's tissues.

Mr. Hovell had bcgun his paper by saying that he felt that everything was sure to go wrong. He could assure Mr. Hovell that everything had gone very right. The mecting was indebted to Mr. Hovell for his paper and to Mr. Fordyce for opening the discussion.

THE AGE FACTOR IN ORTHODONTICS

By **G. G. T. FLETCHER**, L.D.S., D.Orth. R.C.S.

ORTHODONTIC treatments are at best protracted affairs lasting months or more often years. The aim and object of those who treat dental or any other disability should surely be not only to obtain the optimum result but to do so in the minimum of time that skill and knowledge permit. This is particularly applicable to any therapy where appliances have to be worn. Orthodontic appliances may be neat and often ingenious but must nevertheless be considered an encumbrance and embarrassment to their wearers. Moreover, overlong use may produce harmful effects on the tissues to which they are attached or in near contact. Few patients, under any circumstances, would choose to wear appliances for any longer than is necessary.

As knowledge of the aetiology of malocclusion advances so the requirement for trial and error practical approaches should decrease, and it is possible, even with our present knowledge, to start treatment with a clear conception of the complete plan and prognosis in the majority of cases.

This calls for a re-assessment of what does or does not constitute a reasonable average duration for active orthodontic treatment.

As a result of holding these convictions, I began some years ago to focus particular clinical interest upon those treatments that had taken too long achieving too little. The purpose was to discover whether such lengthy affairs came about by necessity or not.

Through clinical observation of my own work and that of others, I gradually formed the view that prolonged appliance therapy was due not so much to patients' failure to co-operate or any intrinsic difficulty of their various orthodontic problems, but to errors of judgement on the part of the orthodontist himself.

Concurrent with the formation of this belief, and as a result of similar clinical observation, I noticed that the treatment of patients in the adult dentition frequently seemed to be carried out both more effectively and speedily than that of younger individuals.

This led me to make an analysis of the treatment durations of orthodontic patients, with a view to ascertaining the relationship in terms of average active appliance duration between those treatments carried out in the adult and those in the mixed dentition. To collect the necessary figures for this investigation the records of 200 completed orthodontic cases carried out at the Eastman Dental Hospital were examined. These patients were unselected and the only qualification was that they had completed a full course of treatment, not limited in its objectives, and had concluded with a reasonably high standard of result. They had been attended by a large number of different individuals using a wide variety of orthodontic mechanical apparatus. The only common ground possessed by all the patients concerned was that their diagnosis was based on the same philosophy.

One hundred of these patients commenced their active orthodontic appliance treatment in the adult dentition and 100 in the mixed dentition stages. To be considered a mixed dentition treatment one or more deciduous teeth needed to be present at the time of fitting of the first appliance and treatment was deemed to have started in the permanent dentition if second premolars or second permanent molars had erupted.

It should be pointed out at this stage that interest centred on the periods in which appliances were being actively worn. Thus if a patient had a central incisor moved over the bite at the age of 8 and wore an appliance for a month for this purpose, then discarded all apparatus until having a final phase of active treatment at the age of 12, lasting 1 year, this would be considered as an active period of 1 year, 1 month, not 5 years. Pre- and post-treatment observation time was for obvious reasons excluded as was that of post-operative retention. The varying ideas of different

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orthodontists concerning how little or how much retention should be used are inconsistent, and the inclusion of retention time would interfere greatly with the clarity of the investigation. Finally it should be pointed out that the figures collected can only be regarded as relative and in no way represent the ideal.

The majority of the patients whose treatment times have been used were under the care of first- and second-year postgraduate orthodontic students working under supervision and other conditions necessary to a teaching organization, but not necessarily conducive to operative quickness. The fully trained and experienced operator working in his own private office should, therefore, think himself accursed if he cannot produce similar or better results in still shorter time.

The number of visits quoted are for all purposes throughout treatment, not merely for the active period.

Table I shows an analysis of the 100 adult and the 100 mixed dentition treatments, and also shows the average age at time of treatment commencement and duration of active appliance therapy for each group.

This table shows that if an orthodontic treatment can be carried out in the adult dentition the chances of very much shorter duration seem much improved over cases commenced in the mixed dentition.

Table II indicates how apparently true this is of the individual as opposed to the average.

The argument will be put forward that not all can be left to the adult dentition stage, but that some must be embarked upon earlier, because by so doing a patient's condition may be rendered treatable, which would not be so were it to be treated later; or alternatively, that the ultimate result of treatment would be greatly improved by such early interference. Such reasons might be considered the justification for early treatment, which would then be undertaken with the full knowledge that the overall time of treatment would be lengthened.

Even if the practical side of treatment of the patients to whom the figures refer was not carried out by experienced orthodontists the diagnosis in each case was, and it could be argued that this experienced diagnostician was in a position to select those who could benefit by early intervention and those who

Table I.—Comparative Analysis of Adult and Mixed Dentition Groups

General Analysis

Stage of Dentition	Males	Females	Occlusal Relationship				Dental Base Relationship		
			Class I	Class II div. 1	Class II div. 2	Class III	Skeletal I	Skeletal II	Skeletal III
Adult	27	73	33	37	20	10	43	43	14
Mixed	35	65	23	54	10	13	37	45	18

Average Age and Treatment Duration

Stage of Dentition	Average Age at Commencement of Treatment		Average Duration of Appliance Treatment		Average Number of Visits
	Years	Months	Years	Months	
Adult	13	8	1	8	30
Mixed	9	11	3	11	45

could be safely left until the permanent dentition had arrived. The figures given in *Table I* could, therefore, be misleading, since the treatment times shown against both adult and mixed dentition groups would merely represent the time necessary for a successful conclusion.

These same 200 patients were arranged in age groups so that the length of time taken for the treatment of each group could be examined.

Table II.—Analysis of Individual Treatment Durations

Duration of Active Treatment	Under 2 Years	Under 2½ Years	Under 3 Years	3 Years and Over
Permanent dentition (per cent)	61	14	9	16
Mixed dentition (per cent)	8	4	11	77

Table III.—Analysis of Age Group Treatment Duration

Age Group	Average Time of Active Treatment	No. of Patients in Group	No. of Appointments
7– 8 yr.*	4 yr., 8 mth.	13	48
8– 9 yr.	4 yr., 0 mth.	19	40
9–10 yr.	3 yr., 7 mth.	19	40
10–11 yr.	4 yr., 2 mth.	26	50
11–12 yr.	2 yr., 7 mth.	29	42
12–13 yr.	2 yr., 1 mth.	29	36
13–14 yr.	2 yr., 1 mth.	24	38
14–15 yr.	1 yr., 7 mth.	17	32
15–16 yr.	1 yr., 9 mth.	14	30
16–19 yr.	1 yr., 4 mth.	9	30

* Includes 1 patient aged 6 yr.

It can be seen from *Table III* that the durations shown against each age group can be further divided into three main collective groups.

Those whose treatment was begun between the ages of 7 and 11 years show a duration of around 4 years; those commencing treatment between 11 and 13 years of age have a little over 2 years' active treatment, and from 14 upwards there is an expectation of the shortest period of all.

It is this last group that is of interest to question the arguments for the necessity of early treatment.

These patients of 14 and over presented for treatment with the adult occlusion already present. The choice of early treatment did not exist and yet not only were they completed in the shortest time, but the results shown on the record models appeared to be better than those of earlier age groups. How many times is an orthodontic problem, seen for the first time in the adult dentition, deemed incurable solely because of failure to obtain early treatment?

The answer to this cannot be found from the records of this investigation, as all the patients contained therein had been treated successfully. Another survey would be needed to find out how many patients attending for the first time as adults had to be turned away on the grounds that they had become incurable because of failure to obtain treatment earlier. In the author's opinion orthodontic conditions are potentially treatable or untreatable, and failure to obtain early treatment seldom, if ever, alters this potentiality.

How many times does failure to obtain early forms of treatment lead to more difficult mechanical tooth movement later? Amongst the 40 patients starting over the age of 14 years that form the third collective group in *Table III*, there should be a few individuals whose treatment took well above the average

length of time due to increased difficulty that might have been eliminated by interference earlier. In fact the longest individual period of these 40 cases was one of 3 years, 2 months, These patients by reasons of either advanced or retarded dental age were in the mixed or permanent dentition, but because of their chronological age they must be in either the

Table IV.—Age Group Analysis at Transitional Period

Age Group	Permanent Dentition			Mixed Dentition		
	No. of Patients	Active Treatment Period	No. of Appointments	No. of Patients	Active Treatment Period	No. of Appointments
9–10 yr.	1	1 yr., 9 mth.	37	18	3 yr., 8 mth.	41
10–11 yr.	5	2 yr., 3 mth.	32	21	4 yr., 7 mth.	54
11–12 yr.	11	1 yr., 8 mth.	36	18	3 yr., 2 mth.	46
12–13 yr.	23	1 yr., 10 mth.	32	6	3 yr., 2 mth.	50
13–14 yr.	20	1 yr., 10 mth.	35	4	3 yr., 2 mth.	48
	60			67		

well inside the average for the mixed dentition. This was the only one of these cases to exceed 3 years; of the remaining 39, 28 completed the required tooth movements in under 2 years. Although the number of patients involved in late mixed or early permanent dentition stages. The awaiting of tooth eruption should here, therefore, be reduced to a minimum. It can be assumed that the last permanent teeth, excluding third molars, have either just erupted or

Table V.—General Analysis at Transitional Period

	No. of Patients in Group	Average Period of Treatment	No. of Appointments
Patients in permanent dentition	60	1 yr., 10 mth.	33
Patients in mixed dentition	67	3 yr., 9 mth.	45

this group is comparatively small, the indication is that very few exist that become so complex that they suffer in terms of time by being left to the permanent dentition stage; it might be admitted, however, that total chairside time for adult treatments may be slightly increased.

It has been said that the time to start orthodontic mechanical treatment is in the very late mixed dentition stage. By so doing some local tooth movement can be carried out whilst the eruption of the remaining permanent teeth takes place concurrently.

Clinical observation has made me question this and *Table IV* was prepared, still using the records of the original 200 patients, but focussing on the second collective group in *Table III*. These are patients whose treatments were commenced between 11 and 14 years of age. are on the point of eruption. *Table IV* shows the relationship of the length of time of treatment between those patients who had reached the adult occlusion and those that were still in the mixed at the time of fitting the first appliance in these transitional age groups.

It will be seen from *Table IV* that 127 out of the full 200 investigated have commenced treatment during the final change-over period from mixed to permanent dentition, which is an indication of the popularity for the belief that this is the best period to start.

It can be assumed that a large proportion of those patients who attended sufficiently early to present the orthodontist with a choice in time of commencement began their treatment at this stage if the temptation for giving even earlier treatment was resisted.

The overall average length of treatment for all these patients is given in *Table V.*

It can be seen from *Tables IV* and *V* that even at this popular age for treatment commencement it is those patients that have reached the adult dentition that have their treatment shortened whilst those that have not quite reached that stage still flounder.

It is plain from these figures that treatment commenced in the mixed dentition will on average lead to a protracted affair and that this is equally true even of the very late mixed dentition commencements. Only with the arrival of the full permanent dentition does treatment time shorten to reasonable proportions.

On the evidence of *Tables IV* and *V* the period of awaiting tooth eruption when working on the mixed dentition cannot clearly be the only faetor in producing their increased duration, and one must look for further reasons.

For further evidence of other possible causes my attention was turned to reviewing the case records of these 200 patients in retrospect, in an attempt, thus endowed with the ability to be wise after the event, to discover any recurring reasons for prolongation.

It appeared certain from these records that the main causes lay partially with failure to elect the ideal time for commencement, but principally to such matters as failure to assess the patient individually, diagnostic and treatment planning indecision and inept, inaccuratc, or inadequate mechanical mcthods.

Theoretical and practical inaccuracies and piecemeal planning lead to prolongation no matter at what stagc of the dentition treatment is inaugurated. Previous clinical observation supported by the evidence of these records causes me to believe that liability to such errors becomes less once the adult dentition is reached and that the logical reasons for this can be shown by reviewing some of the salient featurcs of diagnostic, mcchanical, and patient problems as they relatc to mixcd or adult dentition asscssment and treatment.

PATIENT

Orthodontic patients frequently havc a vital responsibility in thcir own trcatment. It is essential for this that thcy arc capable of intelligent co-operation and are willing to carry out whatever may bc requircd of them through a sincere desire to obtain a specdy and successful outcome. The co-operation of the parents is helpful, but in the long run it is the enthusiasm, or lack of it, on the part of the patients themselves that is the deciding factor in contributing to ultimate success or failure. The older patients are more likely to seek treatment as a result of their own personal desire for it, and if reasonably intelligent will understand explanations of what is involved in the treatment of their condition and can express an opinion of approval or otherwise, thereby greatly assisting the judgement of final objectives when forming a treatment plan.

The willing co-operation of such older persons is infinitely more satisfactory than the docile subservience of the child too young to express himself and knowing nothing of the reasons for wearing a mouthful of wires, but who is carried forward by the enthusiasm of the parent.

MECHANOTHERAPY

From the praetical mechanical aspect of treatment in the mixed dentition, early loss, root resorption, and exfoliation of the deciduous cheek teeth reduce the anchorage available to negligible proportions and consequently slow down thc ratc and quantity of tooth movcment that can be undertaken safely at any given timc.

The arrival of the full permanent dentition provides the orthodontist with firmer and more cxtensive anchorage against which multiple tooth movements can be carried out, at the same time making thc risk of inadvertent movement of the wrong teeth by reciprocal action less likely.

The presence of the permanent dentition with its increascd available anchorage makes the edgewisc or modificd edgewisc multiband appliance systems applicablc to all scgments of thc dental arch, and it might bc thought by somc that it is the use of these complex mechanisms in later treatments that are mainly responsiblc by their multiple and highly

positive actions in reducing the time-factor for the whole of the adult treatment group.

Table VI shows an analysis of the 100 permanent dentition treatments from the point of view of the duration of active treatment in relation to the type of appliance used.

As might be expected, the treatments carried out completely by multiband appliances are shorter than those resolved by other methods. The six months' difference between the time taken by multiband as against simpler techniques, as shown in *Table VI*, would have been smaller, were it not for temptation to save work, and the objection by some patients to wearing bands on their teeth. This has led in some instances to the hopeful use of simple apparatus to attempt to carry out tooth movements for which they are mechanically inefficient or incapable.

Table VI.—Treatment Duration of Adult Group related to Appliance Method

Treatment Method (Appliances)	No. of Patients	Average Duration of Active Treatment
Multiband	37	1 yr., 5 mth.
Part multiband, part simple fixed or removable	20	1 yr., 11 mth.
Simple fixed or removable	43	1 yr., 11 mth.
	100	

Multiband type appliances are particularly suitable to effect such movements as rotations, changes of axial inclination, bodily root movement, and extensive space closure where these occur in multiple fashion in the same malocclusion. Simpler apparatus is applicable to those treatments demanding predominantly tilting actions.

Provided that this is borne in mind when planning treatment, there is seen to be a requirement for both categories of appliances and each will carry out treatment with equal rapidity so long as, while realizing the need for maximum simplicity, the simple type appliance is not expected to exceed its mechanical capabilities.

DIAGNOSIS

Cephalometric analysis and a greater realization of the importance played by the influence of variations of pattern and behaviour of the orofacial musculature upon tooth positions have been two major factors in advancing the diagnosis of malocclusion in recent years. From a study of these two main factors, allied to observation of individual tooth position and size relative to the extent of the tooth-bearing tissues, the orthodontist is now in a position to predict with increased accuracy the final pattern that will emerge from a malocclusion seen in a patient at an early age. There is, however, not yet unanimity of opinion that such knowledge is infallible.

Doubt has been expressed as to whether the pattern of development of the facial skeleton remains constant and in harmony with early cephalometric measurements, or whether there may not be small variations, for example, in the matter of growth direction, or the rate of growth.

Again, the exact forces produced by muscular activity are difficult to assess by direct measurement. The direction of contractions of each muscle conforms to a universal anatomical pattern, but the contractions differ in the degrees and dispositions of their pressure influence on neighbouring structures from individual to individual. Even if clinical assessment of these muscular influences is correctly made in the mixed dentition stage, there is the possibility that through maturation and the superimposition of an increasing amount of conscious control, the adult balance might not be exactly the same.

Even if it is assumed that muscular influence remains constant, there is the fact that the dental arches vary quantitatively and qualitatively during the change from the mixed to permanent dentitions and might react differently to the same environment. If these or

any other potential sources of early error could give rise individually or collectively to a misjudgement of the final adult arch capacity of 2–3 mm. this could lead on occasions to the need for complete re-assessment and re-treatment, or the acceptance of a substandard result.

The statistical figures given earlier were collected and compiled in order to ascertain whether in fact the average duration of active appliance therapy could be expected to be longer when commenced at some stage in the mixed dentition. Their evidence is clear on this

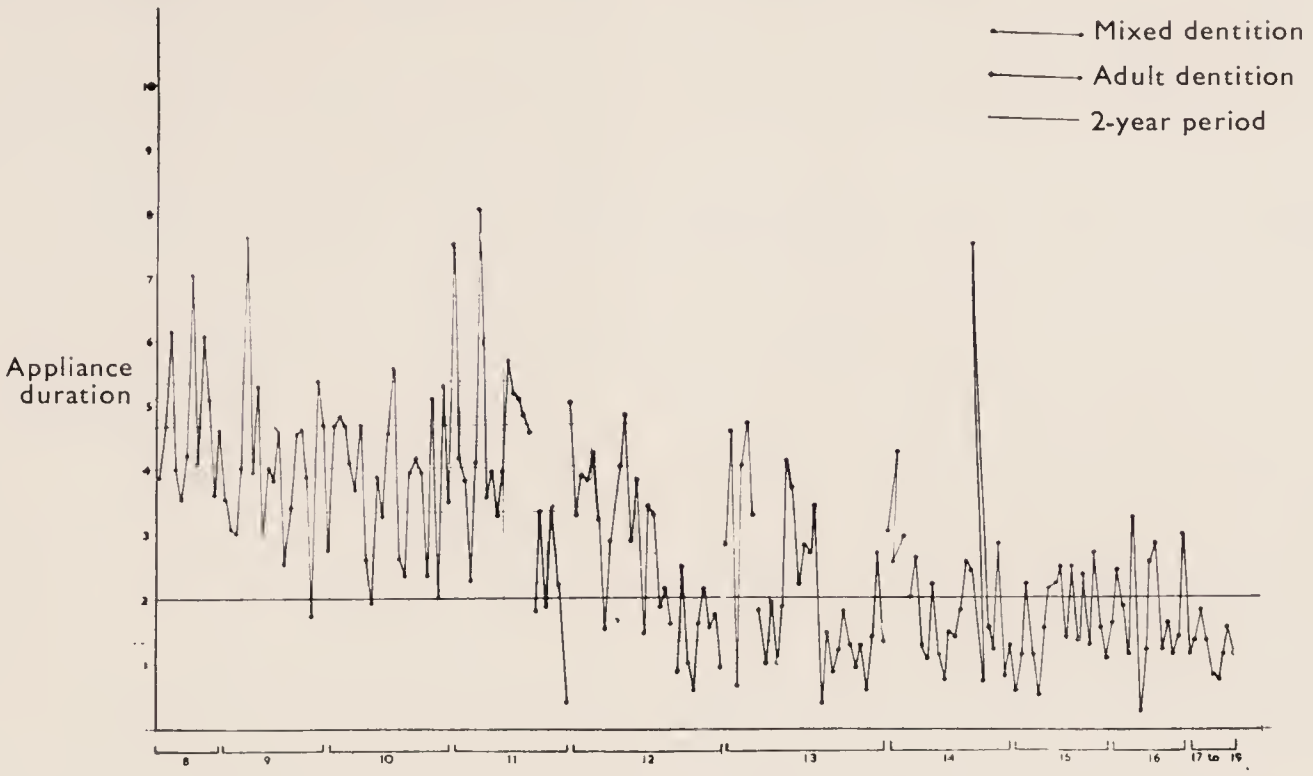

Fig. 1.—In the original graph the lines connecting the individual plots of the adult and mixed dentition treatments were of different colours. Although this aid to interpretation is lost in black-and-white reproduction the graph still shows the gradually decreasing duration and tendency to fluctuate of the active orthodontic treatment times as the patient gets older. The vertical fluctuations will tend to decrease the more trial-and-error methods and assessment are replaced by diagnostic and treatment measures of greater certainty.

Bearing in mind that the practical orthodontist must work in millimetres and degrees, diagnosis and treatment planning supporting treatment commencement must be completely accurate if it is to be of more than largely academic interest.

There is a real danger of building up a treatment on an early false assumption which in turn falsifies subsequent action. The truth may not be discovered until much valuable time and energy have been spent and the mocking sight of relapse pronounces the necessity to retreat from the beginning on different lines.

Treatment planning becomes surer and more objective when the full adult dentition has been present for long enough to have overcome its initial instability and all the factors in the final adult dental balance have exerted their respective influences on one another and the effect of this can be seen and judged on its clinical merits.

point but must be regarded only as an indication and not as proof, since they have been compiled from the records of a comparatively small group of patients at one hospital (*Fig.* 1).

It is certainly not the purpose of this paper to suggest that by commencing in the adult dentition, treatment is in any way automatically shortened, or that prolongation is the inevitable sequel to commencement in the mixed dentition.

CONCLUSIONS

1. If the overall time that appliances have to be worn is to be given due consideration, the occasions when early interference are justified by necessity are comparatively rare. Too frequently early treatment, particularly in patients of 9 years and under, is a system of punctuated progress from one stage to the next, providing a lengthy substitute for the more objective, continuous, and concentrated adult route.

There is an urgent need for more study into the valuc of all forms of carly treatmcnt to investigate thoroughly as to which merely provide a lengthy substitute for later treatment and which, in what circumstances, and precisely to what effect, justify their employment in any given case. Effect should be commensurate with duration, and acts of God and acts of appliance segregated beyond doubt.

2. Study of these 200 case records and their statistical analysis has suggested strongly that not only is early interference frequently superfluous, but also that at all stages of the mixed dentition there is an increased liability to error. Some logical reasons have been suggested why, before the arrival of the permanent dentition, there is an increased risk of failure in assessing the patient personally, of mechanical stultification, blunder, and diagnostic oscillation. Any error of judgement in any of these departments need only be small to result in a considerable increase in appliance duration. Throughout this paper reference has been made to those treatments aimed at achieving the optimum standard of result, and not to those modes contrived to circumvent social and circumstantial difficulties by short-circuiting the true time requirements of a condition by the acceptance of a limited standard of result or by any leaving to chance.

Emergency orthodontic measures must and do exist to cover social and economic demands that prevcnt pursuit of the ideal, but the present-day weight of these demands should not obliterate consideration of what is ideal.

It is possible that many forms of early treatment owe their continued existence in this country to an attempt to overcome social and economic difficulties. By their use it is hoped that more patients can be under treatment in one place at one time, that cost can be reduced or dissipated, and method simplified, so that circumstantial problems can be met without sacrificing the standard of result.

If, however, there is any truth that mixed dentition treatments take, on average, twice as long as the adult, then the younger patient has an expectation of a tedious journey towards successful conclusion. If the conclusion is unsuccessful then he must be satisfied with the interest of that journey.

The patient is entitled to at least the option on the surest and also the quickest treatment available. If we as orthodontists must lead him for years through dark woods of honest ignorance, we must not be surprised on stumbling into the light, if we find, on occasion, that he apparently possessed less faith and fortitude than ourselves and has given up ungratefully through exhaustion and disappointment.

DISCUSSION

The Chairman thanked Mr. Flctchcr for a most interesting paper, one which was most salutory. Hc was sure it was a very good step towards analysing thc timc spent in orthodontic treatment of paticnts. Hc wondered if hospitals were the best placcs for such an invcstigation as he knew how easy it was, with no Dental Estimates Board to placate, to put in another appliance and perhaps use morc than one should. He wondered also if they were not being beaten by the educational system, becausc so often though a patient might spend only a quarter of an hour in the chair it meant spending a half-day away from school; that was one of the controlling factors, the other being that one had to equate the cducational dcmands of the eleven-plus cxamination and the best treatment.

The Chairman asked Mr. Mills to opcn thc discussion on Mr. Flctcher's paper.

Mr. Mills congratulated Mr. Fletcher on his papcr. It was seldom the Socicty had a paper that so dircctly helped the members in their practical treatment of their patients.

Most orthodontists felt that they ought to treat their patients as young as possible. They felt that in that way they might intercept the malocclusion before it became fully established and might even make use of natural growth forces in its correction. Moreover, it seemed wrong to allow thc patient to suffer the psychological trauma often produced by unsightly teeth, to say nothing of the risk of actual physical trauma. Nevertheless, very often these cases drifted on for years and produced a patient with little interest or enthusiasm. Mr. Fletcher had crystallized the situation and had shown that treatment in the mixed dentition took twice as long as treatment in thc permanent dentition.

He was surely right when he had said that our shortcomings lay primarily in diagnosis and treatment planning. Mr. Mills had a dislike of cases in the mixcd dentition. If he treated them he felt that too much was being left to chance. He seldom knew just how thc case would devclop in the way that one knew with the pcrmanent dentition. He hoped the day would come when our greater knowlcdge—particularly of growth and

development—would enable us to treat cases successfully and permanently in the mixed dentition. He was sure that this was the best time from the patient's point of view. For the present, however, we must recognize our limitations and treat at least the majority of cases in the permanent dentition.

There was always a tendency in statistical investigations to lump together conditions which were not strictly comparable. He was sure that Mr. Fletcher would agree that a proportion of cases were better treated in the mixed dentition. He felt that these were almost confined to cases involving a bite of accommodation; in particular, cases with an odd incisor inside the bite, certain postural Class III cases, and cases of unilateral cross-bite which involved a bite of comfort.

Mr. W. J. Tulley added his thanks to those of Mr. Mills for Mr. Fletcher's most interesting and straightforward paper. He found himself largely in agreement with Mr. Fletcher, which was rather disappointing, but even so there were one or two points he would like to raise.

Mr. Fletcher had discussed merely the problem of treatment in the mixed dentition as opposed to permanent dentition, and there was still a considerable body of opinion in the country which believed that one could do useful treatment in the complete deciduous stage, a concept which Mr. Tulley could not condemn too strongly.

Some years ago he had commenced treatment for a lot of children at the ages of 3 and 4, and some of them were still with him in their teens. Those who were not might well have cured themselves anyway. He thought that most active treatment in the deciduous dentition was a complete and utter waste of time.

Another point was that Mr. Fletcher had been talking mainly about fixed appliance technique. Mr. Tulley would have liked to have known a little about the duration of each visit, but he realized the difficulties of analysing such things. That was something which had to be taken into account in weighing up fixed and movable appliance therapy; the surgery time was important. He would have liked an analysis of the type of cases Mr. Fletcher was dealing with. There again statistics could give a bias.

The period of the late mixed dentition was obviously the most popular because so many of our treatments involve reducing the number of permanent teeth, frequently the first premolars, which did not erupt until 10. One did not like surgically removing them too frequently.

However, it is most important that orthodontists should be given the opportunity of seeing children at an early age and seeing the dentition growing up. They did not want to train orthodontists who did not start to see children until the age of 12, and he was sure Mr. Fletcher would agree with that.

Mr. O. N. Catchpole said he had been taught that there were two advantages of treating the child young. One was that if a tooth had to be rotated it stayed in position much more easily if it was done before the tooth was fully formed, so that a portion of the root was formed in its new and proper position. The other was that sometimes there was damage to the teeth as a result of wearing fixed apparatus. If the work was done during the life of the deciduous teeth and the fixed apparatus was fastened to the deciduous teeth, that damage went when the teeth were shed and the permanent dentition had a clean fresh start.

Mr. A. G. Taylor asked on what basis were the cases selected. Were they a consecutive series of cases? They appeared to be the type of case that would be referred to hospital for specialist consultant treatment rather than the common round of orthodontics one would find if one took 1000 consecutive children in a school.

Mr. J. C. Ritchie said that there was no mention made of any treatment under the age of 7 years. That seemed to imply that at the Eastman Dental Hospital treatment was not carried out at that age. "These lumps of protoplasm", as Mr. Fletcher had called them, were to Mr. Ritchie some of his best patients and some of his best friends; he thoroughly enjoyed treating them and was very glad to see them every time they came in. He could not agree with Mr. Fletcher that to treat orthodontic cases in the temporary dentition was a great mistake. He had carried out many treatments in the temporary dentition which had shown no relapse whatever, and he was thinking particularly of the Class III malocclusion.

He had had the privilege of treating a set of uni-ovular quadruplets—probably unknown in the history of this country before—who all had a Class III malocclusion. The first time he had seen them was when they were about 4 years and 9 months old. In the space of 15 months each child had achieved a normal occlusion. He hated to think what sort of an orthodontic problem they would have made at the age of 13 years.

Mr. H. G. Watkin thoroughly agreed with what Mr. Fletcher said; he thought it was important to see the child early and to take impressions. Then to see the child again in twelve months and commence treatment, if such is indicated. It was most important that impressions should be taken and studied early.

Mr. T. Jason Wood asked Mr. Fletcher to comment on two very simple forms of treatment which he had found most useful. In the congenital Class III he did not think extra-oral traction could be started too soon and had even been started with great effect at 2 years of age.

The other simple treatment was most applicable in the mixed dentition period described by Mr. Fletcher on being likely to prove lengthy. The oral screen was most useful in improving lip relationship and incisor relationship while awaiting the eruption of cheek teeth, and frequently little was then left to be done but make room by extraction. The appliance was easily worn at night only, by the child, who usually readily co-operated if it was explained that much full-time appliance wearing later on would be saved.

Mr. E. J. R. Bird asked if Mr. Fletcher had found any difficulty with the adult dentition-treated children who leave school at the earliest possible moment. He found sometimes they would go to him and tell him that they had left school and did not want to carry on the treatment, even though they may be half-way through their treatment. He considered that to be one of the greatest snags in treating the 13- and 14-year-olds.

Mr. Fletcher said that there were a number of circumstantial matters, such as schooling, which had to be taken into account. Individual circumstance had to be treated on its merits and related to the type of treatment involved. These circumstantial problems were an integral part of treatment planning. One would be unwise to be dogmatic about commencing treatment at any particular age but if one allowed circumstances alone to cause one to start treatment early against one's better judgement, patient and parent should be informed of the likely consequence to the overall time.

Mr. Mills had raised a point with regard to physical trauma to upper incisor teeth in Class II, division 1 malocclusion as to whether early treatment was not

justified in this type of case to offset liability to fracture. Mr. Fletcher said that there were undoubtedly some cases where this could be done safely and without time wastage, but again one could not be dogmatic, because there were other types of cases where early intervention would be singularly ineffective. He cited as an example a Class II, division 1 malocclusion on a Class II dental base with incompetence of lips and incipient buccal crowding. In such a patient the overjet could be reduced only very slightly without fear of impaction and so forth. This overjet reduction would be too small to make any difference to possibility of fracture should this patient fall on his face.

Mr. Fletcher agreed with Mr. Mills that the incisor behind the bite and lateral cross-bite were conditions worth while treating early if diagnostic factors permitted and natural retention existed.

On Mr. Tulley's point with regard to the duration of visits, Mr. Fletcher said he had not investigated this because the cases used for the compiling of the statistics were almost all treated by first- and second-year post-graduates who might spend several hours in the construction of one band that could be passed as satisfactory by his instructor. To discover average chairside time involved, more experienced operators should be used to provide data. Mr. Fletcher said he would volunteer the information that a full band up involving all the teeth of both arches would require at least six hours' chairside work.

Mr. Fletcher agreed that orthodontists should have the opportunity to see their patients before the age of 12. A great deal could be learned by watching general development in growth and maturation, and, additionally, local development by observing the natural behaviour of teeth as they settle into equilibrium unhindered by appliance.

In reply to the question about the type of case, Mr. Fletcher said that his first table had shown that a good cross section of all the malocclusions had been used to compile the statistics. He was not sure whether this was the answer Mr. Tulley required or whether by "type" he meant social category.

Mr. Tulley said he had wondered whether they were teeth inside the bite or malocclusions.

Mr. Fletcher said they were full malocclusions. Some were simpler than others, as one might expect if no selection were involved, but all had been treated up to the requirements of their conditions.

In answer to the question as to whether early tooth rotation before the apex was closed resulted in increased stability, and to the question as to whether early appliance wearing was desirable on the ground that trauma would be confined to the deciduous teeth, Mr. Fletcher said that he did not think any increased stability was to be had purely by rotating the tooth early. On the second question he said that he supposed that if one was unable to treat orthodontic patients without producing trauma then it would be best to confine it to the deciduous dentition, or better, give up orthodontics.

In reply to the question as to whether the cases were extraction cases or not, he said that a large number were, and a large number were not. The cases were just the sort one would meet with in any clinic or practice. A few had been very difficult ones referred for specialist treatment because no one else dared face them, but most were perfectly ordinary malocclusions such as one would meet anywhere. None was treated by extraction alone.

Mr. Ritchie said that his very young patients seemed to get on all right, and he enjoyed treating them. Mr. Fletcher asked Mr. Ritchie if he were sure his patients enjoyed being treated. Mr. Fletcher said he had been an orthodontic patient himself and had suffered four and a half years' early treatment which turned out to be ineffective. He had been polite to the practitioner concerned only because he was well brought up and too young and inexperienced to say what he really thought. He was sure Mr. Ritchie could produce results, because he had worked with him, but was he sure that he need start so young? Mr. Ritchie had said that Class III cases respond well to early treatment and this agreed with what Mr. Mills had said. With regard to the use of chin-straps, Mr. Fletcher said that these might achieve some local tooth movement which would be beneficial but he doubted their claim as regards skeletal development. In patients that had seemed to benefit he thought it possible that a claim was being made for what would have happened anyway.

The optimum time of treatment was a matter of individual assessment. Obviously it would be right to start treatment sometimes in the mixed dentition. For the majority the age would be, if one could wait so long, not only when the adult dentition was there but when it had been there for long enough to have settled into final equilibrium, and initial instability had been eliminated.

Someone had mentioned that late treatment may well interfere with schooling and that sometimes the patient left school before treatment was finished and decided not to continue. This was a good example of the sort of thing one was duty bound, if possible, to discover before treatment was started. Such circumstantial matters comprised what he had referred to in his paper as patient assessment and this often had a profound effect towards limiting objectives when planning treatment. Mr. Fletcher then cited an incident that had occurred at the Eastman Dental Hospital where a patient announced that the family were going abroad for three years a fortnight after commencement of treatment. This could have been discovered by sensible questioning beforehand. Since there was no orthodontist in the particular part of the globe to which the patient was going, here was a circumstance of sufficient gravity to cancel any form of projected treatment at least for the time being.

Mr. Watkin had advised taking an impression early. Although Mr. Fletcher had not mentioned that, he did agree that it should be done. One must have something for the purpose of comparison; one could not remember after seeing a great number of other patients the exact details of any particular dentition.

He thought he had answered Mr. Bird when dealing with another question. One should find out everything circumstantial that might have the effect of limiting the objectives in treatment beforehand. As a rule, if the patient was really keen, they could usually find a way by which the treatment could be completed.

The Chairman thanked Mr. Fletcher for a most instructive paper.

Reverting to the point about length of treatment, he knew adults who would come 15 or 16 times a year for 2 years, whilst others in the mixed dentition would come about 11 times a year for 4 years.

He thought some of the dental students who had started as patients had been among their best cases.

The discussion had been very good and left the members with much food for thought, and he thanked everyone who had joined in.

THE EARLY ORTHODONTIC TREATMENT OF CLEFT PALATE CONDITIONS

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THE title of this paper, "The Early Orthodontic Treatment of Cleft Palate Conditions", was selected in the interests of brevity. It is intended to include both clefts of the primary and secondary palates and also to embody the morphological rationale of what might more justly be described as the McNeil technique.

It is now some 4 years since McNeil (1954) first published his original work on the early orthodontic management of cleft palate and hare-lip conditions, and those who have followed this work will be aware of the storm of controversy which it aroused, both in the field of orthodontics and also in that of plastic surgery. It will be remembered that the centre of this conflict was whether or not it was possible to secure union of a cleft palate by non-surgical means. In contrast, the less spectacular, though more important, aspects of the technique, the pre-operative correction of the maxillary arch deformity and its relationship with the mandibular arch, have been somewhat overlooked. Those who have been called upon to provide orthodontic treatment for the gross arch deformities which can attend conventional cleft palate treatment will no doubt appreciate the intractability of these conditions.

For some considerable time the pædiatric and plastic surgeons of the Liverpool area had been concerned at the lack of dental follow-up of cleft palate and hare-lip conditions, and as a result of a meeting of all parties concerned it was decided to form a unit to ensure that full and effective treatment was provided. At this time the work of McNeil was known but not understood, and the writer was fortunate enough to be sent to Glasgow, where he was privileged to observe the work which McNeil was undertaking. Following on this it was decided to institute a pilot scheme in the Liverpool area, which has now been in operation for two years. The following represents a brief report of this work, together with certain observations drawn from embryological and morphological findings. It must be emphasized that this is in the nature of an interim report, and very much remains to be done both in the clinical field and in basic science, but that the results have been sufficiently encouraging for the technique to be adopted as a routine procedure.

EMBRYOLOGICAL FACTORS

Before proceeding to the clinical findings, it is necessary to state as briefly as may be the salient features of the development of the face and palate. Classical theory of the development of the face has postulated the existence of various facial processes which "fuse" during development. Originally, and indeed until relatively recent times, this process of fusion was held to imply ectodermal fusion, as though these processes were individual "fingers" in space which grew together and fused by the destruction of their extodermal covering layer.

Following the work of modern embryologists, notable among whom must be mentioned Streeter (1951) of the Carnegie Institute of Washington, it became realized that the facial processes consisted of mesodermal masses migrating forward between the ectodermal covering of the face and the roof of the oral cavity. In this way no ectodermal fusion is called for, but rather a smoothing-out of ectodermal folds. Following on these observations on normal embryos, Stark (1954) has reviewed the state of knowledge concerning the pathogenesis of hare-lip and cleft palate and has added his own observations based on the study of five hitherto undescribed cleft palate embryos.

Given at the Jubilee Meeting held on May 9, 1958.

Modern theory holds that on the fusion of the neural folds to form the brain, certain cells are extruded from the neural crest and that these cells migrate down the side of the head to form the cranial ganglia and the visceral arches. The experimental evidence supporting this theory has been adduced from work on amphibia, which, having free-living larvæ, are well suited to this approach. This work has been well reviewed by Horstadius (1950). Investigation of the origin and behaviour of the mesoderm in amniotes has had to rest on the examination of close series of histological preparations. Bartelmez and Evans (1926) and Baxter and Boyd (1939) examined the problem in man, while Burston (1953) investigated a very close series of sheep embryos and was able to demonstrate a marked correlation with the experimental findings in lower forms.

The migration of neural-crest cells into the visceral arches takes place at 24–26 days. In so far as the mandibular arch is concerned, a secondary caudal extension of this mesoderm then occurs which pushes round beneath the brain towards the midline, thus forming the maxillary processes. However, on either side of the face there are two residual areas where the ectodermal coverings of the face and that of the roof of the oral cavity (in its most anterior part) remain close together. These areas—the olfactory placodes—are somewhat pear-shaped in outline as seen from the front, with the narrow part extending downwards to involve what will be the lip. Between the two ectodermal layers forming these areas there is only a very thin layer (a few cells thick) of the original mesoderm. As the adjacent mesodermal extension from the mandibular arch (maxillary process) continues to grow, the contour of the face takes on the characteristic bulges of the facial processes and the olfactory placodes appear to sink in to the face. These events have been well described and figured by Streeter (1948 a).

Two points now arise:—

1. It has been stated that the floor of the olfactory pit consists of two layers of ectoderm in close apposition and that the most dependent portion of this area potentially involves the lip.

2. The embryo is growing very rapidly and the main function of the mesoderm at this stage is to provide a vascular supply, since the original process of diffusion of fluids is no longer adequate to sustain the life of the cells in so large a mass.

Hence the whole of the olfactory placode would be in danger of breaking down, were it not for the fact that in normal development a part of each maxillary process passes beneath the main upper portion of the placodes, thereby separating the two layers of ectoderm and forming a bar of tissue which is the primitive palate. The upper portion of the olfactory placodes continues as thin double membranes, which are now known as the bucco-nasal membranes, and these eventually break down to form the two primitive nostrils. (Streeter, 1948 b.)

The formation of the primitive palate is complete by 5 weeks, and from this structure is derived the upper lip and premaxillary region of the maxillary complex as far back as the naso-palatine canals, which for practical purposes may be taken as the region of the incisive foramen.

It follows that should there be a failure of either or both of the maxillary processes to extend beneath the olfactory placodes, the latter split right through to the lip and a hare-lip will result. The actual position and extent of the cleft(s) will, of course, depend on the degree of failure of the mesodermal extension.

It is possible to distinguish, therefore, clefts of the primary palate, which from the clinical standpoint are seen as clefts of the lip, varying from minor notches to an involvement of the nostril. These clefts may be either unilateral or bilateral, and may or may not involve the alveolar process in the incisal region.

Although clefts of the primary palate are frequently associated with clefts of the palate proper, they can and do have an independent existence (*Fig.* 1). They must have occurred before the 5-week period and they are formed by a breakdown process rather than by a failure of fusion.

The formation of the secondary palate, by the fusion of the maxillary palatal processes with each other and with the inferior border

of the nasal septum, is well described in many standard works. Certain points are, however, worthy of emphasis:—

1. The palatal folds emerge at about 8 weeks, that is, very much later in embryological time than the formation of the primitive palate.

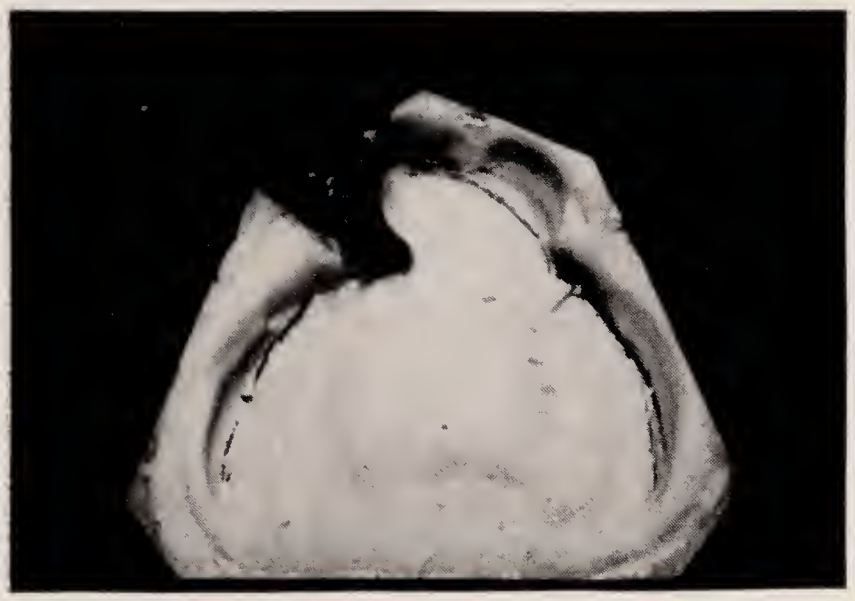


Fig. 1.—Total unilateral cleft of primary palate only.

Fig. 3.—Total unilateral cleft of primary and secondary palates.

2. These processes are at first vertically disposed on either side of the tongue, but at about 9 weeks, consequent on the descent of the mandible, the folds come to lie above the tongue and fuse from before backwards with the nasal septum, to form most of the hard and also the soft palate.

3. This is a true process of fusion involving the degeneration of the overlying ectoderm. Ectodermal remains may be seen in histological sections for a long time after fusion is complete.

Various factors may arise to interfere with this process, among the most probable of which are:—

1. When the cleft of the secondary palate is associated with a previously occurring cleft of the primary palate, it is reasonable to postulate that there has been a gross interference with the migration and development of the original maxillary process, so that either or

Fig. 2.—Total bilateral cleft of secondary palate only.

Fig. 4.—Total bilateral cleft of primary and secondary palates.

Fig. 5.—Total unilateral cleft of primary and secondary palates on the right, sub-total unilateral cleft of the secondary palate on the left.

both of the definitive palatal processes are reduced in size and fail to reach the midline.

2. There may have been a failure of the epithelial coverings of the palatal processes and septum to degenerate and hence prevent mesodermal fusion.

3. There may have been a failure in co-ordination between increase in width of the head as a whole and the development of the palatal process.

4. It is possible, as has been pointed out by Scott (1955), that cyst formation may occur in the degenerating epithelium and that these cysts could break down.

5. In a rather special category is that the failure of the mandible, and hence the tongue, to descend may have prevented the palatal folds coming into apposition. It is felt that this mechanism is probably a principal cause of clefts of the secondary palate only, particularly where these are also associated with micrognathia of the mandible.

Fig. 2 illustrates a total bilateral cleft of the secondary palate. Clefts of the primary and secondary palate may combine in various ways as is shown by *Figs.* 3–5.

A consideration of the failure of the mandible to descend involves a prior study of the cranial base. The definitive cranial base is formed from cartilaginous elements which rapidly fuse to form three main structures: the inter-oribital nasal septum; the hypophysial plate; and the parachordal plate surrounding the notochord in what will be the basi-occipital region of the definitive skull (de Beer, 1937). These three elements fuse together, but for some considerable time the sites of union, particularly the posterior one, are very tenuous and but poorly chondrified (Burston, 1953).

Consequent on the precocious development of the brain, the head of the embryo is curled over onto the pericardial region, so that the mandibular arch is trapped between these structures. The angle between the inter-orbital nasal septum and the parachordal plate is almost 90° with the apex at the hypophysis. Owing to further differential growth in the various parts of the brain, this flexion is steadily decreased, the opening taking place at the junction of the parachordal and hypophysial plates in what is termed the posterior basi-cranial fenestra. It is this change in the basi-cranial axis which lifts the head away from the pericardial region and enables the mandible to grow downwards from the cranium. Any failure in this mechanism will be liable not only to produce a cleft of the secondary palate but also to interfere with the normal growth of the mandibular arch, at a time when the primitive skeletal relationships between the jaws are being established.

LATER MORPHOLOGICAL FINDINGS

It is now necessary to consider the cranial base at a much later stage of development from six months intra-uterine to birth and thereafter. Scott (1953), Kettle (1954), and Glass (1955, 1956) have emphasized the importance of the nasal septum in the development of the maxilla, but so important is this structure to this early orthodontic treatment that it must be considered again at this stage.

The inter-orbital nasal septum in the fœtus, and indeed in the infant up to 2–3 years of age, is an enormous structure, lying almost entirely within the face. A baby has only a small snub nose, yet within the face the septum stretches posteriorly as far as the basi-sphenoid.

Ford (1956) examined a series of fœtal skulls from 10 to 40 weeks, and has shown that the septal region increases six to sevenfold in this period compared with the remainder of the cranial base, increasing by a factor of four to five.

At birth the cartilaginous nasal septum accounts for half the length of the entire cranial base measured from the rostral extremity to the foramen magnum.

Laterally, the nasal septum is in relation with the vertical plate of the maxilla via the nasal cupola, while inferiorly the septum is in direct relation with the maxilla in its anterior part (*Fig.* 6). Any growth of the septum must therefore have a profound effect on the development of the maxilla at this stage, and indeed it is this growth of the nasal septum which is responsible for the separation of the maxilla from the rest of the skull and consequent deposition of bone in the sutures joining the maxilla to the adjacent bones.

An initial survey by X-ray methods of the cranial base of post-mortem specimens shows that this state of affairs persists to about the $2\frac{1}{2}$–3 year period. (*Fig.* 7.) During and after

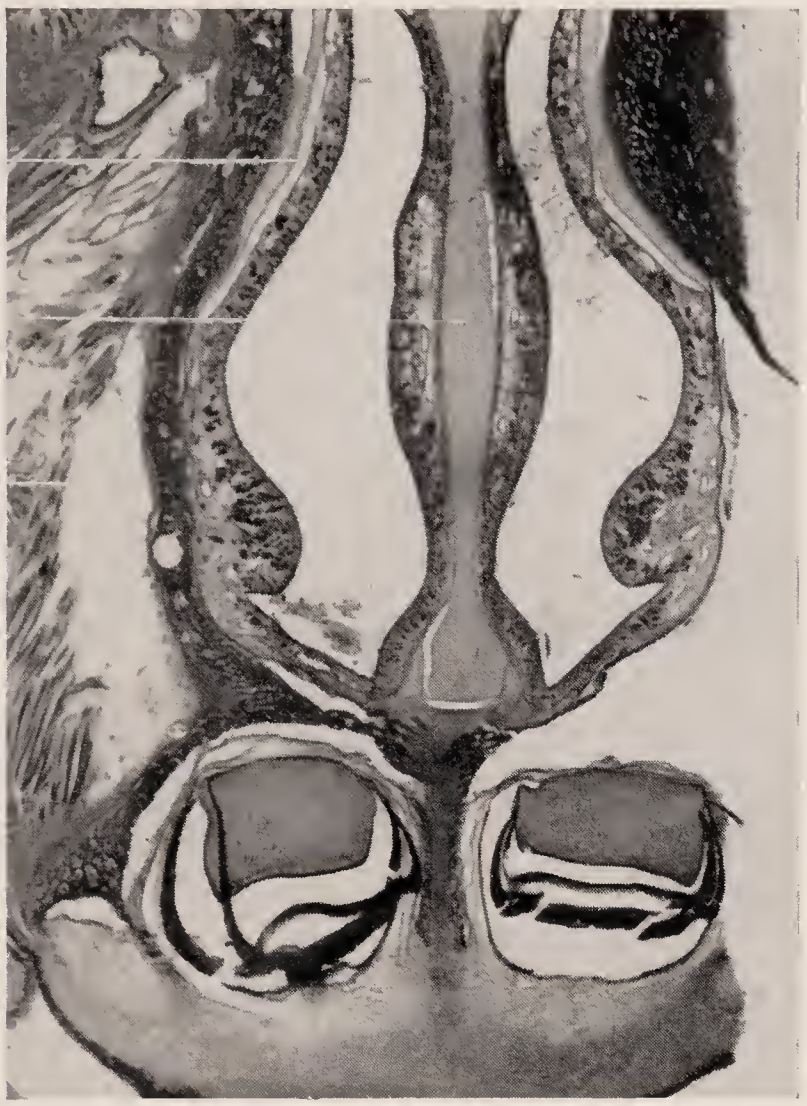


Fig. 6.—Frontal section through the nasal region of a full-term human fœtus. Note the relationship of the 'keel' of the nasal septum (N.S.) to the maxilla (M) and the way in which the vertical plate of the maxilla is invading and ossifying the nasal cupola (N.C.).

this time the intra-facial portion of the cartilaginous septum, i.e., the part in association with the maxilla, is gradually replaced by the bone of the mesethmoid from above and also ossified from below from the vomer. The cartilaginous element persists anteriorly and grows on the face to form the definitive nose (*Fig.* 8).

Once the intrafacial part of the septum is ossified, the capacity for separation of the posterior facial suture system (Scott) is of course greatly reduced, and the radiographs shown confirm Scott's analysis that after the age of 3 years the emphasis on maxillary growth is shifted progressively in favour of surface deposition.

It now remains to examine what may happen when Nature performs an experiment in disconnecting either one or both maxillæ from the influence of the nasal septum.

Fig. 9 represents schematically the typical deformities that can arise in cases of clefts of

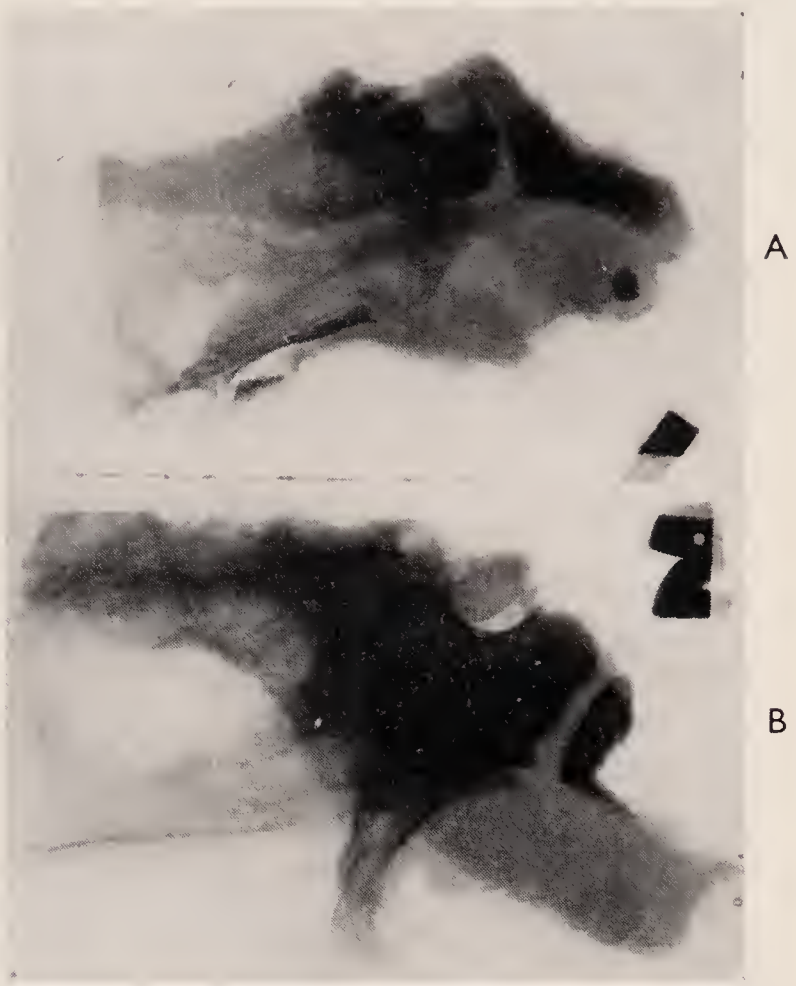


Fig. 7.—A, X-ray of the cranial base of still-born human. Note the large cartilaginous area underlying the anterior cranial fossa (the anterior $\frac{1}{8}$th of the septum was left in situ at post-mortem); B, X-ray of the cranial base of a 2-year-old child (post-mortem specimen). The large area of cartilage underlying the anterior cranial fossa is again well seen.

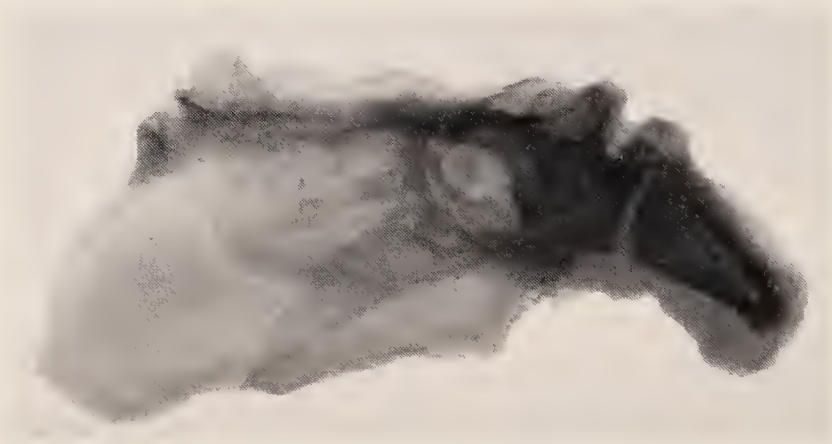


Fig. 8.—X-ray of the cranial base of a $4\frac{1}{2}$-year-old child (post-mortem specimen). Note the way in which the intra-facial portion of the septum has been ossified by the mesethmoid and vomer while the cartilaginous portion has grown forward to form the septum of the definitive nose.

the primary and secondary palate. Considering first the unilateral defects, it will be noted that in each case the lesser segment is underdeveloped in an anteroposterior direction.

Type A occurs less commonly and is characterized by a midline deviation of the lesser segment, the major segment being but little disturbed. Type B is much more commonly seen, and here the major segment has deviated to the non-affected side. Again the lesser segment is under-developed and its alinement

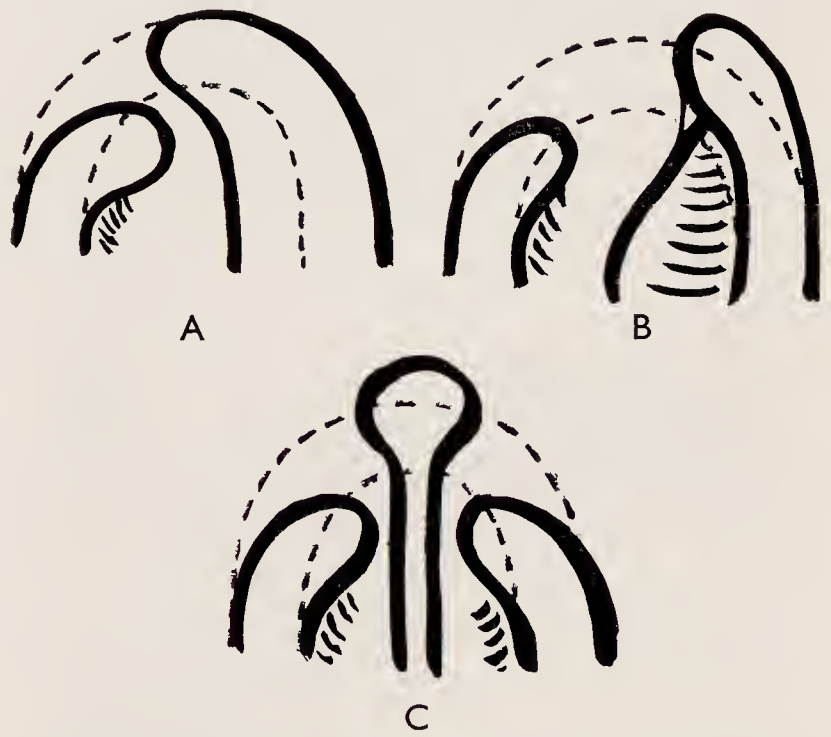


Fig. 9.—Schematic representation of the maxillary arch deformities occurring in unilateral and bilateral clefts of the primary and secondary palates. The dotted lines show the presumptive arch form in each case.

with respect to the lower arch would appear to depend on whether or not the tongue has invaded the line of cleft. It is suggested that the failure of the lesser segment to grow forward to its true position is due in large part to its being denied the growth impulse of the nasal septum proper. The nasal cupola is comprised of very thin cartilage and in consequence fails to bring the maxilla forward once this is separated from the keel of the nasal septum. These cases are marked by a very stretched and tense ala of the nose on the affected side, and if this condition is allowed to persist, may materially lessen the chances of the surgeon producing an æsthetically acceptable nostril at lip closure (*Fig.* 14 A).

The bilateral condition (*Fig.* 9, Type C) is characterized by two retroplaced and small maxillæ. Very frequently this condition is also associated with a certain degree of micrognathia of the mandible. The central stem carrying the premaxilla is *relatively* protrusive. It should be noted that although this latter element may be somewhat rotated in an upward direction, the actual amount of true over-development is often quite limited and the major defect lies in the retro-placed maxillæ.

The normal surgical procedure for unilateral defects appears to be to wait for some three months before attempting primary lip closure. The reason for this is that once the immediate neonatal period is passed, and with it the protection conferred by the maternal antibodies, it is necessary to wait until the infant has become stabilized to independent existence before operating. Three months' delay has been found the best compromise between the general condition of the patient together with the convenience of increased size of the lips as against the progressive deformity which often occurs with delay. Attempts have been made to operate in the immediate neonatal period in order to minimize the deformity, but this procedure has not so far been generally accepted.

Various techniques have been advocated for lip closure, but for the purpose of this paper these may be divided into those that undertake closure of the anterior palate at the time of lip operation, and those that confine attention to lip closure only.

Whichever technique is followed, the lip has to be closed over a considerable defect in the alveolar arch, and this repair, together with the Logan bow (which is applied to relieve the sutures of tension), inevitably results in some collapse of the alveolar segments. In cases where the pre-operative position of the segments chanced to be favourable, the skill and artistry of the surgeon might well produce a very acceptable maxillary arch in good relation with that of the mandible. Much more commonly, in the writer's experience, has been the collapse of the maxillary segments to greater or lesser degree dependent on the original position of the fragments (*Fig.* 10).

The McNeil technique affords a means of correcting this mal-position pre-operatively, and hence gives the surgeon a firm foundation around which to reconstruct the lip and also make æsthetically acceptable nares.

In the bilateral clefts of lip and palate two main surgical approaches have been adopted. Both techniques recognize the progressive nature of this deformity and both undertake the first operation at about the 6-week

Fig. 10.—Typical collapsed maxillary arch following unassisted surgery in a case of total unilateral cleft of the primary and secondary palates.

period, accepting the risks of operating at this age in the interests of relieving this gross deformity.

The first technique, used by those closing the anterior palate at the time of lip operation, consists in closing first one side at the 6-week period. The case is thus converted into a unilateral defect, often with marked deflection of the septum and nose towards the repaired side. At the 3-month stage the other side is then closed. The object is to use the reconstituted lip to prevent further discrepancy between the central stem and the lateral maxillary segments. The difficulties arising are the large depressions left in the alveolar margin between the premaxillary and maxillary segments together with the almost inevitable ensuing midline collapse of the lateral segments.

The second technique, as exemplified by the Denis Browne operation, reduces the premaxillary protrusion at a preliminary operation. This is achieved by resecting part of the vomeral bone and nasal septum, thus allowing the premaxilla to be pushed back, and sometimes rotated, to fit between the lateral segments of the maxilla, where it is fixed by a metal splint. Lip repair is undertaken at a second operation.

The disadvantage of this technique is that it sets back the premaxilla to the maxillary segments which are already retro-placed, consequent on under-development. It therefore follows that in subsequent development the

Fig. 11.—Profile of a 9-year-old child who suffered from a bilateral total cleft of primary and secondary palates and for whom a "push-back" operation of the premaxilla was performed.

upper jaw remains small, the mandible continues to grow, and the child presents with a "depressed middle third" of the face, the discrepancy tending to increase throughout the growing period (*Fig.* 11).

Unhappily, at the time of the push-back operation, the mandible itself may be somewhat retro-placed, so that arch alinement and arch relationship both appear ideal. It is only later when the mandible continues to grow normally that the discrepancy becomes apparent. Further, not only may the premaxilla be pushed back beyond its proper position, but surgical interference to the septum inhibits the all-important growth-centre referred to previously.

The writer is not suggesting that all push-back operations must necessarily deteriorate to a marked degree, for where the original defect was relatively small, surgical reduction

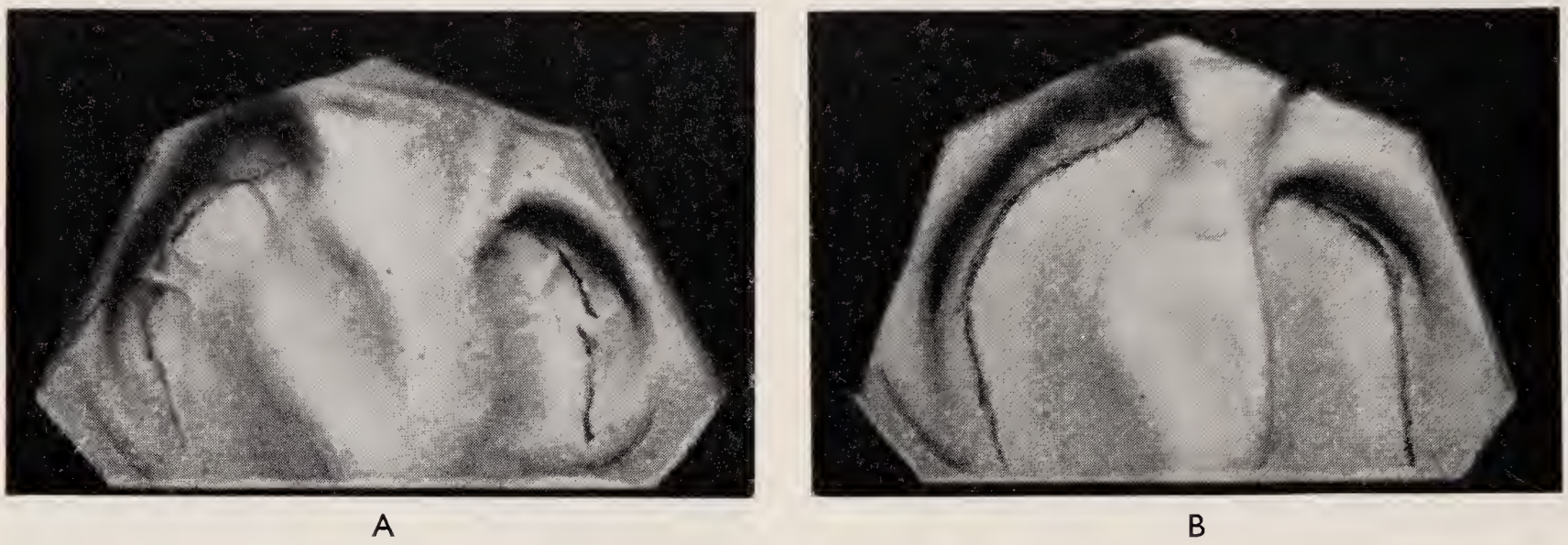
will likewise be small and the resulting deformity will be minimal. Nevertheless, experience of follow-up of many of these cases has shown that "the depressed middle third" of the face is a characteristic feature.

Once again, early orthodontic treatment aimed at limiting further precocious development of the central stem, but more particularly bringing the maxillæ forward pre-operatively, does yield marked benefits in the treatment of these conditions (*Fig.* 17).

The McNeil technique involves commencing treatment as soon after birth as possible. Experience has shown that treatment in milder cases may be deferred up to six weeks, but on the whole "the earlier the better" is the guiding principle. This has the merit of providing the child with a roof to its mouth, and hence greatly facilitates the feeding problem in the neonatal period.

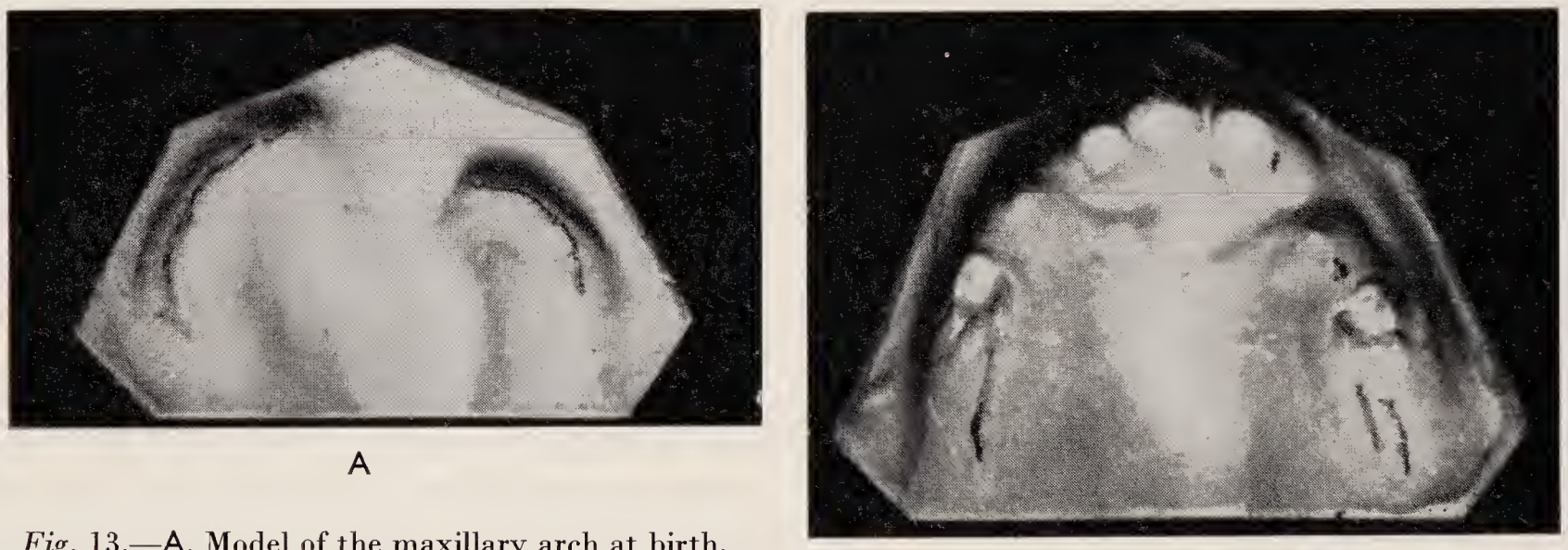
McNeil has already described the actual details of the construction of the plates used in this early orthodontic therapy and the writer has substantially followed the same technique. It will be recalled that a composition impression is taken of the upper dental arch and a plaster model prepared. The arch deformity and arch relationship to the lower jaw and rest of the skull are analysed by a consideration of the factors discussed above.

From this analysis it is decided what corrective measures are required, e.g., if the



A B

Fig. 12.—A, Model of the maxillary arch of a very wide total unilateral cleft of primary and secondary palates at birth. B, Model of the same baby at 4 months showing the optimum pre-operative reduction obtained. Any further reduction (as by extra oral strapping) would have brought the line of the maxillary arch within that of the mandible. It is suggested that there is gross deficiency of tissue in this case, and that the appropriate surgical treatment would be closure of the anterior palate at the time of lip operation, the orthodontic aim being to maintain the maxillary segments in good relationship to the mandible. The resultant notch in the alveolar border will eventually be masked by a suitable denture.

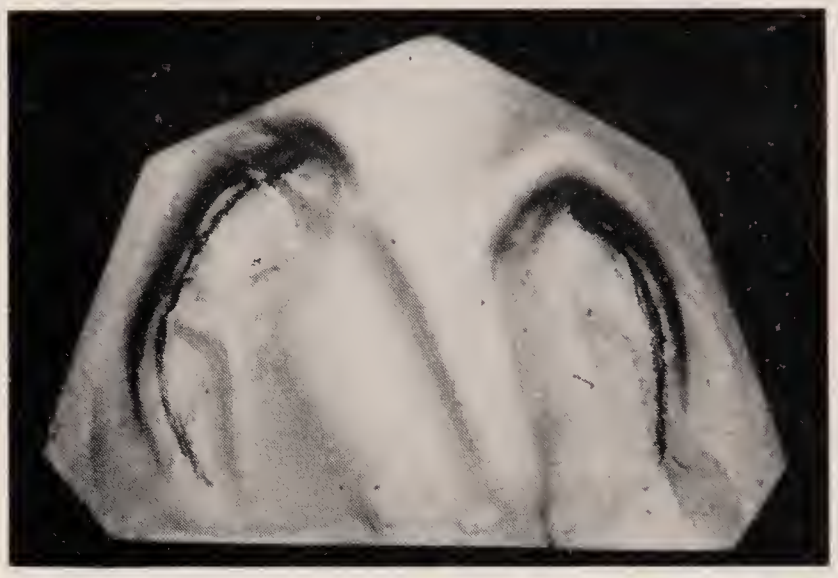


A B

Fig. 13.—A, Model of the maxillary arch at birth. B, Model of the same child at 18 months following orthodontic treatment. The maxillary arch is in good relationship with that of the mandible. Lip operation was performed at 4 months and the palate has recently been closed.

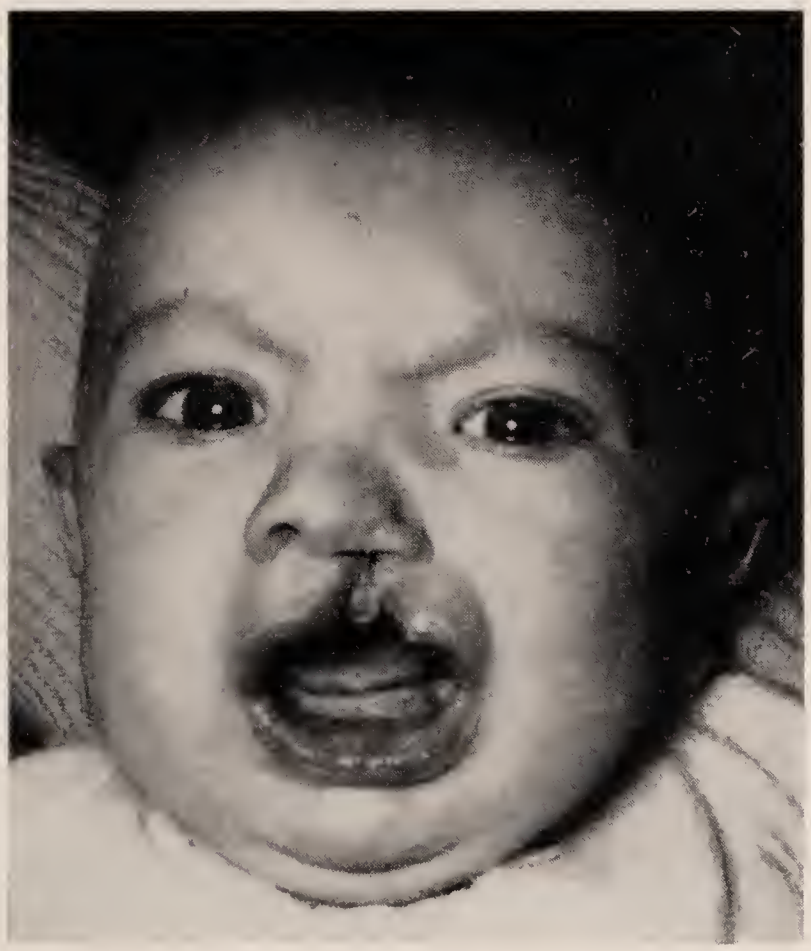
lesser segments needs moving forward and/or outwards, or whether midline correction of the major segment is neeessary. The model is then eut at the appropriate plaees and the segments moved in the required direction, after whieh the model is re-based. The aetual amount of eorreetion applied at any one time is a matter of elinieal judgement, but it is of course related to the rate of growth of the ehild. It follows that in the early stages, little or no correction may be made, so that the first plate is largely a feeding plate to aeeustom the baby to wearing a plate. Increasing correction may be applied when the ehild has passed through the neonatal period and has entered the phase of rapid growth (4–6 weeks and onwards).

A



B

Fig. 14.—A, Frontal view of infant at birth suffering from a total unilateral cleft of primary and secondary palates on the left side. Note the defleetion of the midline of the nose and maxillary areh to the non-affected side. The left ala of the nose is tense and the flattening of the left side of the maxilla can be seen. B, Model of the maxillary arch of the same baby.



A

B

Fig. 15.—A, The same infant as *Fig.* 14 following orthodontie treatment. Note the closure of the alveolar defeet and the reduetion in the asymmetry of the middle third of the faee. In repose the margins of the lip are in eontaet. B, Model of the maxillary areh showing the pre-operative reduction aehieved. There was elinieal "union" in the anterior palate region in this case.

A bite-bloek is made in soft earding wax to the eorreeted model and the infant's bite is registered in a slightly gagged position. At the time of taking the bite, the eentre line of the

head as a whole is recorded in the wax—this is of great help in trimming the record models and in assessing the deviation of the parts.

A simple acrylic arch alinement plate is then made on the corrected model. From what has been said, it will be apparent that this plate is not an accurate fit in the infant's mouth and it is the action of "biting the plate" that achieves the desired moulding and stimulation of the maxillary processes.

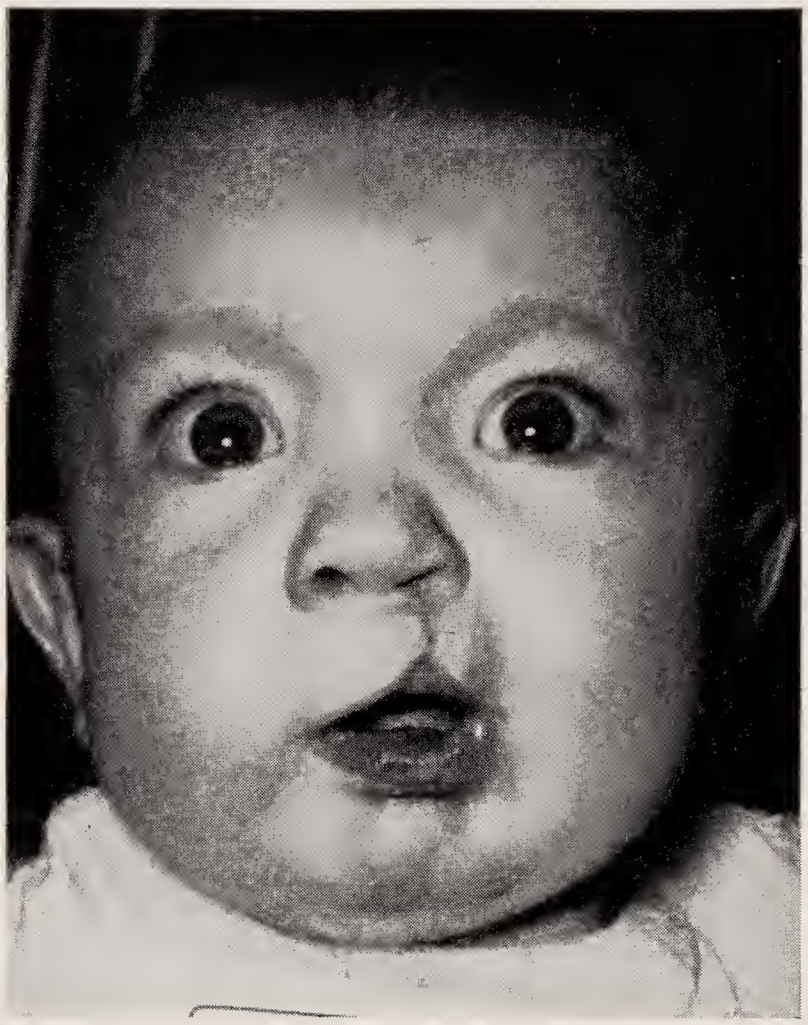


Fig. 16.—The same child following lip repair. Note especially the symmetry of the face and the excellent balance of the nose. The red margin of the lip will be dealt with at a subsequent operation.

The internal action of the plate may be reinforced by external elastic strapping where necessary. This is nearly always called for in bilateral conditions, but may also be used to correct a deviated centre line in unilateral cases. Care has to be exercised that the action of the strapping and that of the plate are not mutually antagonistic.

The amount of correction obtainable or desirable in any given case depends on the extent of the original deformity and on the technique of the individual surgeon. Where there has been a gross reduction in the size of the parts, it may well be impossible to secure arch alinement and at the same time preserve a correct arch relationship with the mandible (*Fig.* 12). On the whole, however, complete pre-operative arch alinement, and at the same time acceptable arch relationship, is obtainable in the majority of cases.

Regarding surgical technique in relation to the pre-operative arch alinement, a distinction has to be made between those procedures aimed at closing the lip and anterior palate on the one hand and those closing the lip only. In the former case, full pre-operative reduction of the alveolar defect would prevent the surgeon gaining access to the mucoperichondrium covering the side of the nasal septum and to the mucoperiosteum of the nasal surface of the palatal fold. Such access is required to raise the two flaps required to form the floor of the nose and at the same time constitute the repair of the anterior palate. Hence, in these cases a compromise in arch alinement is sought

A B

Fig. 17.—A, Model of the maxillary arch in a bilateral total cleft of primary and secondary palate. B, Model of the maxillary arch of the same child showing the pre-operative reduction obtained.

and an endeavour made to position the segments so that the resulting post-operative collapse will produce an acceptable arch in good relationship with the mandible.

In those surgical techniques which do not attempt to close the anterior palate at lip operation it is necessary to ensure firm apposition of the alveolar segments (i.e., complete closure of the defect) and ideally this should be obtained prior to lip operation. The reason for this is that it will not be possible to close an anterior defect at the subsequent palate operation because a flap, such as the Veau flap, cannot be brought far enough forward. This raises the question of what has happened in such lip closures before early orthodontic therapy was undertaken. It is a matter of common observation that in, say, the Denis Browne type of operation, a residual alveolar cleft is by no means a constant finding. On the contrary the usual picture appears to be that of a collapsed arch, but one having firm "clinical" union in the anterior region. It is suggested that this "union" must have been brought about by continued firm apposition in the same way as it occurs in embryological fusion. It is thought to be a pressure necrosis of the overlying epithelium brought about by the continuing pressure.

The benefits conferred by orthodontic therapy are therefore to bring forward the underdeveloped segments, and to correct any lateral deviation that may be present, by a process of controlled collapse and moulding of the arch segments. In this way the surgeon has a firm foundation around which to mould the lip, and the resulting growth processes will take place along more normal lines, e.g., the nasal septum will be able to play its proper role.

Clearly there will be those cases where there is such a gross deficiency of tissue that pre-operative treatment cannot fully reduce the defect and at the same time produce a large enough arch for good relation with the mandible (*Fig.* 12). This type of case calls for a surgical technique which closes the anterior palate at the time of operation. The result is that the alveolar segments remain in good relation with the mandible, but there remains a notch in the alveolar border requiring a prosthesis at a later date.

Following lip closure, plates are inserted to maintain arch alinement and to stimulate the growth of the palatal processes. The McNeil type of sprung activator has been used for this purpose. The rationale behind this is the well-known principle that if the blood-supply to growing tissue can be increased hypertrophy is likely to occur. In the writer's experience, the gap in the hard palate does reduce considerably prior to secondary palate closure, and in many cases apposition of the palatal folds with the central stem has occurred. The maximum amount of fusion that the writer can claim is about one-third the total length of the hard palate. In the interests of speech, it has not been deemed worthwhile deferring closure of the palate beyond the 12–18-month period in the interests of securing further "non-surgical" union. The close apposition of the palatal folds does, of course, mean that the surgeon can concentrate on pushing back the soft palate rather than closing a wide lateral defect.

Internal support is maintained until the deciduous teeth are in occlusion. Time alone will show how well the arch relationships will be maintained, but the results so far are encouraging and the surgeons are convinced that the therapy helps their lip and nose repair.

Figs. 13–17 illustrate results obtained by early orthodontic treatment.

Some mention may be made of the administrative arrangements under which the work has been carried out.

Ideally an infant is seen as soon as possible after birth and treatment is commenced in the maternity hospital, or if the infant was born at home it is transferred to hospital. The child is accustomed to the plate and feeding difficulties are overcome, after which the child is discharged home, providing domestic conditions are satisfactory. Treatment then proceeds on a domiciliary basis until the child is ready for lip operation, or it is deemed fit to attend as an out-patient.

Where the home is too remote or otherwise unsatisfactory, the infant is usually admitted

to hospital for the whole of the pre-lip operative treatment, or alternatively, where the defect is not great, may be brought in for a shorter but more intensive course of treatment.

Following lip closure the child is kept in hospital for a short time to acclimatize it to the new plate, and is then discharged home. Further treatment is continued on an out-patient basis until the time of palate closure and during the subsequent follow-up period.

A recent advance is the provision of a special ward in a babies' hospital which is reserved for these cases and where the nursing staff can be trained in the handling of these conditions.

In this way, also, special precautions can be taken against cross-infection of these babies, an ever-present danger in larger children's wards.

Acknowledgements.—It is a great pleasure to acknowledge the kind courtesy of Dr. Kerr McNeil, Glasgow Dental Hospital and School, who so generously made available to me the benefits of his experience in this work, of which he was the pioneer.

I am also greatly indebted to the medical and nursing staffs of the Liverpool Children's Hospitals for their fullest co-operation and help; especially am I indebted to Miss Isobella Forshall and Mr. Rowland P. Osborne, the senior consultant pædiatric and plastic surgeons respectively, with whom I have been privileged to work, and who have accorded me every facility and encouragement.

I should also like to thank Dr. F. Hudson, consultant pædiatrician, Liverpool Regional Hospital Board, not only for the ward which he placed at my disposal, but also for medical cover and advice in the treatment of these children during their stay in that ward.

I also wish to acknowledge the freedom granted me by the Liverpool University to undertake this work, especially in the persons of Professors H. H. Stones and F. E. Lawton, immediate past and present Directors of the Dental School.

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DISCUSSION

Mr. M. A. Kettle, in opening the discussion, said he thought Dr. Burston had to be congratulated most heartily on the way in which he had presented his paper, and he thought everyone would feel better for the fact that one as energetic and as keen as Dr. Burston was pursuing the problem of the cleft palate.

The problem of the cleft palate was one which was staring all orthodontists in the face, and he thought they should all do more about it.

Mr. Kettle said he would like to open the discussion more from the clinical angle, although Dr. Burston had gone into the embryology of the subject in some detail.

The use of the technique which had been described, the repositioning of the segments of the upper arch, was something which obviously had to be accepted as a method which had in some cases a very definite and practical application. In the case of the bilateral cleft of the lip and palate the surgeon was faced with a great problem, and one could quite see why the pre-vomerine section was often removed with such disastrous results in the past. On the other hand, modern surgeons —and surgery has undergone a tremendous change in ten years—do not do that, but tend to stretch the lip over the prolabium. In those cases there would be a very distinct advantage in moving the prolabium back into a better position so that the surgeon could have a very much better subject to work on. He would be a little more hesitant in suggesting that the benefits would be quite as great in the unilateral type. One big problem was that as the child grows the depression in the middle third of the face persists. Everything that could be done to promote and encourage the forward growth or forward positioning of the anterior part of the maxillary arch should be done, because that would be doing a great service to the patient, holding the upper lip forwards and giving the patient a very much better facial contour and profile.

In the unilateral type, where the segments were repositioned prior to operation, there would obviously be a baekwards movement of the anterior part of the larger segment. It would be seen that that was the only way to bring the two together, whieh meant that when the surgeon operated on the lip (although he would have a slightly easier task in moulding the lip on to the newly positioned upper areh) he would be working down to a depressed bone segment and the lip would elearly be too far baek already.

Mr. Kettle said he would not dream of eritieizing anything Dr. Burston had said, beeause he felt that anything done to help ehildren with eleft palates was good, but he thought that in every ease Dr. Burston had shown post-operatively the upper lip was definitely set baek in relation to the rest of the faee. They all had a look about them whieh he did not like, espeeially in the immediate post-operative period. He had seen many ehildren post-operatively whose upper lip seemed to be projeeting too far forwards, but that did not last very long. The relative apportionment of growth as the lower jaw eame down and the rest of the faee built round it meant that the prominenee of the upper lip deereased very rapidly. Even in early adult life one was worried about the faet that the lip was set in rather too far but one never worried if it was set too far forwards. That was the biggest point he had to make against the method whieh had been deseribed. He would mueh prefer some means of holding the anterior part of the upper areh forwards rather than have it moved inwards.

The immediate effeet of the lip operation was to eause a eollapse of the segments, but where the lip operation was sueeessful it gave the patient an aetive, mobile, upper lip. In this type the greater eollapse was in the region of the lesser segment, and that in itself had the desirable effeet of holding the anterior part of the greater segment forwards. In the unsueeessful operation where the lip was either tight, thiek, or immobile, one found the greater inward movement taking plaee on the anterior part of the larger segment, giving a result very mueh like the ones that had been shown after repositioning. It was for that reason that Mr. Kettle was a little worried about the method, beeause the patients who at the age of 6 looked slightly pre-normal ehanged to ehildren who looked markedly pre-normal later on.

The greatest benefit, he had found, was derived in eneouraging the forwards drift of the upper areh at 6 or 7 years of age. At that stage the use of the oeeipitomental anehorage tended to eneourage the upper areh forwards and also to ehange its bueeolingual relationship with the lower areh. By this means a normal bueeolingual relationship of the eheek teeth eould be produeed without any lateral expansion of the upper areh.

The only other thing Mr. Kettle did not like about the method deseribed was that in using an applianee from the very early stages, one was eommitted to retention plates over a long period of time. Cleft palate patients are very prone to earies, and to them the loss of a tooth was a very vital thing, partieularly if it eame from the line of the eleft. Therefore, if one was submitting a patient to plates from the early stage and reekoning on eontinuing through with some sort of retention plate, one was obviously inviting the onset of more and more caries, with disastrous results.

Mr. Kettle said that after all that eritieism he wanted to thank Dr. Burston very mueh: he was not really eritieizing, but trying to extend another point of view so that more people would join in the diseussion.

Dr. Burston thanked Mr. Kettle and said he was afraid he did go through the details of the teehnique regarding the treatment of the unilateral type of case too quiekly. He entirely agreed with Mr. Kettle as to the futility of trying to push baek the larger segment; that was something he had tried to suggest was *not* done in the teehniques he had deseribed. In this teehnique they were trying to bring the lesser segment forwards. He drew an illustration on the board showing that if the septum was deviated and, with it, the larger segment displaeed laterally all that was attempted was to eorreet this deflexion, the aetion of the plate being reinforeed by extra-oral strapping as the last resort.

He agreed that the aetion of the plate and strapping would, if wrongly used, be mutually antagonistie. What was done was to eoneentrate on bringing forwards the lesser segment, whieh was probably assisted by the tongue thrust into the plate, at the same time moulding the larger segment by suitable eorreetions applied to the plate. If this failed eompletely to reduee the deviation of the larger segment, then extra-oral strapping was used, together with a plate designed to maintain the lesser segment in good position while the anterior portion of the larger segment was moulded into the plate by external pressure.

Beeause he had not wished to speak for too long he had not mentioned an attempt they were making to reeord areh relationships in these infants. Briefly, it eonsisted of obtaining models of the maxilla and mandible and artieulating these with the aid of a bite taken in the "rest position", i.e., the baby ehewed the bite to a position of eomfort. Wires were then adapted to the erest lines of the dental arehes and a sheet of soft wax inserted between the artieulated models. The artieulator was then elosed and the wires pressed into the wax. The sheet of wax with the embedded wires was then radiographed and gave a graphie illustration of the anteroposterior and lateral relationships of the maxillary segments with respeet to the mandibular areh.

With regard to earies, Dr. Burston agreed that the preservation of the teeth was vital to these ehildren. An organization existed whereby the ehildren were followed-up at 3-monthly intervals after this early treatment had been eoneluded for this very purpose. It was not always easy beeause the soeial baekground of some of the parents was sueh that it was almost impossible to eontend with home eonditions.

Dr. Burston and others who believed aeidity was an important faetor in earies advised the use of magnesia on the fitting surfaee of these plates to try to eombat deeay, and on the whole this appeared to be effeetive.

Regarding retention of the maxillary segments it would take a few years before they eould really judge the results. However, at present they tried to maintain the areh relationship until the deeiduous teeth were in oeelusion.

On the whole Dr. Burston eonsidered the teehnique had generally minimized the gross deformations oeeurring to the maxilla that so frequently followed unassisted surgery. Even in the worst eases he thought the treatment brought the ehild within the range of normal orthodontie proeedures.

The Chairman opened the topie for general diseussion.

Mr. D. Greer-Walker said he had known Dr. Burston's work for many years, and he wanted to eompliment Dr. Burston on that work, and upon the faet that he had tried to taekle the problem from a basie seientifie angle.

With regard to Dr. Burston's point of the failure of the lesser segment and the over-development of the premaxilla, one often heard people mention the word "collapse" after any operative procedure. This was erroneous in a sense because what Dr. Burston had put forward had to be viewed from a slightly different angle, namely the growth potential and the related potentials of the different parts.

In his work on gross deformities, Mr. Greer-Walker had always found it extremely difficult to analyse what was really the primary deformity and what was a secondary change in that primary deformity. He could give a good example from his work on hypertelorism where, basically, there was a first arch failure, a failure chiefly in the maxillary process and the offshoot of the maxillary process which formed the lateral wall of the middle fossa. What one found there was the failure of the maxillary process causing a strain upon the nasal process.

When one saw cleft palate deformities, it was necessary to bear in mind that owing to the separation of the maxilla from the premaxilla the sequence of potentials of growth was very greatly upset, and that was why he would differ slightly from Mr. Kettle. One could argue that the premaxilla was free to go in its primitive direction. What Dr. Burston might be doing was to a certain extent placing the premaxilla back where it might more rightly belong.

In thinking of clefts it was important to think of the question of the growth impetus, realizing that clefts could occur in any type of cranial facial morphology. So often people looked at a cleft and said, "Here is a Class 3". The surgeon was blamed, but it may well be that that patient might have been a Class 3 irrespective of the cleft.

The treatment was extremely important at this early stage, and so valuable on account of growing bone. Everyone knew that with conditions such as the Pierre Robin syndrome, the intra-uterine malformations along with talipes were postural defects, and when a child was born one found a return to the original form. One can assume at this early age there is the plasticity present which would allow some readjustment to take place.

It had been a great pleasure to listen to such a very valuable contribution as that made by Dr. Burston, and Mr. Greer-Walker said he wanted to thank Dr. Burston very much.

Dr. Burston thanked Mr. Greer-Walker and said he was very much indebted to him for many acts of kindness and help in the study of the conditions he had mentioned and related conditions.

Terms such as "collapse" were descriptive. If they were going to be more than descriptive terms, there would thereby be the imputation that the whole secret of the embryological process was known. One talked about growth potential, but to Dr. Burston that was getting very near to saying the secret of life itself. In embryology one could observe the fact that an embryo goes through certain stages which could be recognized under a microscope, but it did not explain how it reached one stage from another or yet the vital property of neural crest material; it did not explain how from the crest it turned into, say, the mandibular arch and the maxillary process extending over the roof of the oral cavity to form the two condensations in which the nasal septum would develop. How these processes took place was not known, but they were implicit to life itself. One was on very difficult ground when one started to argue about such things, because it was so easy to develop to the level of metaphysical argument, and that was an extremely difficult topic.

Dr. Burston had tried to use descriptive terms in their common usage, but of course he did not know why a cleft palate occurred. From analysing it he could say when a cleft must have occurred in the development, but that was a long way from describing how it occurred. Therefore, he would not like to stray into the question of growth potential, important as it was, for it brought in the question of genetics and opened up a very wide topic.

Mr. D. F. Glass said that anyone who has heard the earlier discussions on the subject would realize how much everyone disagreed on all the points. Not only was there disagreement among orthodontists but the plastic surgeons were sceptical about the claims made by orthodontists.

Dr. Burston had prescnted a very good paper, although there were some points with which Mr. Glass did not agree. He was pleased that Dr. Burston did not claim that he had obtained calcified union across the cleft. The plastic surgeons thought the orthodontists were saying they got ossification across the cleft, and until this could be definitely proved, no wild claims should be made. Mr. Glass was pleased that Dr. Burston had been reserved in his statements.

Having seen some of the cases who had been treated in the manner described by Dr. Burston, he thought the tissue produced across the clefts or towards the clefts was not good. It has the appearance of the tissue one found under a lower denture that did not fit. What was Dr. Burston's opinion of this tissue!

Mr. Glass did not understand how the segments of the maxilla could be moved forwards. These segments are attached to the pterygoid plate or the sphenoid, and any movement must be a swinging action in an outward or inward direction with the fulcrum at the pterygo-maxillary suture.

It was fashionable to follow the trend of orthodontics of the period, and the idea that the pre-vomerine resection was wrong had arisen. Mr. Glass was not prepared to say whether it was right or wrong, but before it could be condemned out of hand the work of Cronin should be considered, because he had obtained some very good results by a very special technique done by expert plastic surgery.

Mr. Glass did not agree with Mr. Kettle on some of his ideas, and he thought the whole problem was very involved. He preferred to treat the patients later. The idea of swinging out the lesser segment was right, but he considered it should not be done before 3 or 4 years of age ; if segments could be alined in 3 to 6 months, surely that was better done when the teeth were present. It was not a matter of orthodontics but of dental orthopædics.

Mr. Glass said he hoped to be able to talk to Dr. Burston later, and he said it would not be necessary to reply to his question immediately.

Dr. Burston rather gathered that Mr. Glass was criticizing him for something he had not said, and he (Mr. Glass) was almost sorry he had not said it. All he was prepared to say was that he had given an interpretation as seen by one individual.

With regard to the clinical "union", it was solid; if one pressed upon it with a ball-ended spatula it would not move. He would not be prepared to say what it was until some plastic surgeon trephined the area, but he

would not ask a plastic surgeon to trephine a baby just to have the satisfaetion of knowing. The Germans had done that, and he understood that McNeil had histologieal evidenee. His own evidenee was hearsay and he would not pass it on until he had seen it himself. Of course there was no fundamental objeetion from an embryologieal point of view, and that was why when he had asked to see McNeil at work, he had approaehed him with an open mind. He did not regard the teehnique as a panaeea of all eleft palate troubles, but thought it a valuable adjunet to surgery.

In reply to a question by Dr. Burston, Mr. Glass said he had not been talking about the lesser segment of the premaxilla when on the topie of pushing the maxilla forwards but the lesser segment of the eleft.

Dr. Burston said a eleft eould be regarded as Nature's experiment. Dr. Scott had given several very elegant analyses of the method of growth in the skull, and everything that took plaee in the eleft fitted that pattern, so one could look at the cleft palate side of it as Nature's experiment and proof of what Dr. Seott had worked out in another way.

On the question of the reseetion of the vomer and septum and push-baek of the premaxilla, he had seen eonditions in whieh the surgeon, with the greatest skill, had assessed the slight degree of over-development of the eentral stem and been prepared to settle for a reduetion at the time of the first operation, and the final result had been extremely desirable. There was, however, no seientifie method by whieh to assess it at the time of operation. Many reseetions of the septum had produced a depressed mid-third of the face. To him the whole essenee of development was balanee, the eartilage, neural tissue, membrane, and bone all working together in a state of balanee, and anything that interfered with that balanee was bad, and anything that eould be done to restore balance, however imperfeet, was good. He regarded the teehnique as a harnessing of the membrane bone back to the influenee of the eartilage of the septum and the strapping, where used, as an artifieial substitute to eorrect soft-tissue aetion while awaiting lip repair.

Mr. J. C. Ritchie congratulated Dr. Burston on his communieation and agreed with almost everything he had said.

Having carried out such work for four years, there were one or two things he had learned. First of all, in the very early days, in many eases one was dealing with a rather poor speeimen. It had been his experienee that a ehild who was fitted with an applianee to enable it to suek at a very early age derived a tremendous advantage. The teehnique was usually to take an impression at two days old and to fit a simple base-plate with bite-block attaehed in eorreet oeelusion for sueking purposes at three days old, so that the moulding of the alveolus could be done more or less at one's leisure. In this respeet he had found it advantageous to do the moulding in at least two and possibly three stages; he did not believe eollapse would take place if the moulding was done gradually. It was unneeessary for an applianee to be worn after a lip operation, apart from the few days immediately following the operation.

In his experienee the moulded segments had stayed together extremely well and had shown no deterioration after the teeth had erupted.

Dr. Burston thanked Mr. Ritehie and explained that as McNeil had already published his findings on his elinieal method he had not thought it neeessary to stress the faet that they did proeeed, as Mr. Ritehie said he did, in several stages, the amount of eorreetion put on eaeh time being related to the growth rate of the ehild. Initially, before growth was taking plaee, they used an almost uneorreeted plate to get the ehild aeclimatized to a plate and to get it feeding. The nursing staff and the pædiatrie surgeons were very appreeiative of sueh a plate beeause it enabled the ehild to suek, the only proviso being that a teat with a slightly larger hole should be used so that the ehild would not beeome too tired too quiekly.

With regard to eollapse, one had to be eareful after a lip operation. Where one did sueeeed in getting the "union" aeross the alveolar segment it appeared to be self-maintaining, but he had one ease whieh had lined up very nieely and about whieh he had been very happy, but he did not maintain it long enough and he found the trouble recurring; it was in the ease of a surgeon who did not close the anterior palate at the time of operation. The lip was very loose following operation, henee the two maxillary fragments were not held in elose eontaet so that "union" might oeeur. He had subsequently overeome this diffieulty by the use of suitable plates and extra-oral strapping and the result now appeared stable (i.e., 12 months after operation).

Mr. J. H. Hovell thought it was extremely interesting to see how the workers on eleft palate orthodonties were following so elosely the idea and theories that were put forward by the workers on general orthodonties when orthodonties first beeame a speeiality. Angle, at his sehool, had said that by doing orthodonties early the ehild was enabled to reach growth potential. That had all gone by the board; all the extravagant elaims of the past had been disproved. These elaimants harmed orthodonties by elaiming too mueh—supermen who changed geneties.

Mr. Hovell thought something of that nature was taking plaee now in early eleft palate orthodonties. He thought that some workers on cleft palate orthodonties were trying to claim too mueh for changes whieh in faet they eould not produce, and that they were doing their speeiality harm by elaiming too much.

The work Dr. Burston himself was doing was very valuable work, but its main value was in eontrolling the plastie surgeon and giving him a better basis on whieh to work, so that he would not do unneeessarily mutilating operations on the lips and premaxilla. He hoped Dr. Burston would earry on with his work and would improve upon it, but suggested that too mueh should not be claimed for it.

Dr. Burston said he had been at great pains to avoid elaiming too much for the work. He emphasized that he had no ulterior motive, that it was not his work, it was MeNeil's work. Anything he had said he would take full responsibility for saying, but when MeNeil first put over the work there was a storm of eontroversy about it, although it seemed to Dr. Burston that the basis of the teehnique was eminently right from the embryologieal and morphological standpoints. The teehnique merely harnesses together tissues whieh have beeome separated.

He himself had only been doing the work for three years, but he had the baekground of people who had given a substantial part of their lives to treatment of these eonditions, such as the two surgeons with whom he said he had had the privilege to work, and they were satisfied that from the elinieal point of view they wanted the technique. Much work remained to be done in the laboratory, but in the first instanee the test had to be

in the clinical sphere. He had been asked to go and try the technique, and that was all he had done. Those who had been working on it and who had vastly more experience of it were satisfied that it was conferring benefits on the children. That was as far as he was prepared to go in making claims. All they were doing was giving the surgeons a better chance to develop their art, and that was all he would claim for it.

The Chairman said that Dr. Burston had kept a very difficult subject in complete perspective. He thanked him for what he could only describe as a *tour de force* and said how envious he was of anyone who knew his subject so well that he could talk around slides without effort.

Mr. Kettle had spoken of Dr. Burston's energy and enthusiasm which he (the Chairman) knew from his own experience extended to the cutting of all sections; to worrying other hospitals and departments for specimens; and collecting them all himself. He felt sure the work was of fundamental value and had a bearing not only on cleft palate problems but on general problems of growth and development.

The Chairman thanked Dr. Burston for his paper and Mr. Kettle for opening the discussion.

A CLINICAL ANALYSIS OF OROFACIAL MORPHOLOGY AND BEHAVIOUR OF 500 PATIENTS ATTENDING AN UPPER RESPIRATORY RESEARCH CLINIC

By **H. L. LEECH**, B.D.S., F.D.S. R.C.S., D.Orth. R.C.S.

In 1951 I had the good fortune to be appointed Clinical Assistant to the Consultant Dental Surgeon of the Victoria Hospital for Children, Chelsea, and as such, worked under the direction of Professor Ballard and Mr. Gwynne-Evans in the Upper Respiratory Research Clinic.

After much deliberation a punch-hole card filing system was drawn up with the object of assisting our researches into the relationship between the patterns of orofacial morphology and behaviour, and into their relationship with certain disorders of the upper respiratory tract in the patients attending this clinic (*Fig.* 1). This system is by no means infallible; it is only a beginning and there must be a universally accepted definition of the terminology if it is to be successful. I shall explain our interpretation of these definitions as they appear throughout this paper, which does little more than indicate the lines on which further research should be instituted, possibly on a more scientific or statistical basis.

Many of the concepts of orthodontic thinking, such as the relationship of ear, nose, and throat disorders to orthodontic irregularities, have been generally accepted, but those antagonists who propound one theory against another have been able to produce few and often false statistics to support their contentions. It was with the object of providing figures to support or deny these contentions that this research was made.

MATERIAL

The material available consisted of 500 patients attending the Upper Respiratory Research Clinic for Diseases of the Ear, Nose, and Throat. They were not selected for orthodontic purposes, and therefore the results of the research are more applicable to the general population as a whole than is the case where the research is carried out on patients selected purely from those attending an orthodontic clinic. A case history of each patient was taken with the help of the parent (nearly always the mother) and the clinical examination was supported by the lateral and occipitomental radiographs normally taken for ear, nose, and throat purposes; no cephalostat was available for the lateral radiographs and no tracings were carried out.

Those who consider lateral skull radiographic tracings essential to all research may consequently belittle this paper, but whilst such research accessories as the cephalostat may be of inestimable value we must not overlook the fact that the assessment of skeletal patterns from correlations of the various angles measured is primarily the result of clinical judgement. Furthermore, one of the values of studying lateral skull radiographic tracings is that from their constant use one can sooner or later acquire the faculty for assessing the skeletal morphology with a high degree of accuracy from the radiographs alone.

I have used the Angle's classification of the anteroposterior relationship of the teeth, assessing the relationship between the upper and lower buccal teeth in their original position of eruption in soft tissue balance and making allowances for changes of molar position due to premature loss of the deciduous teeth.

Owing to the mobility of the dento-alveolar structures on relatively fixed bases the Angle's classification does not, of course, necessarily coincide with the skeletal classification.

Given at the Jubilee Meeting held on May 9, 1958.

In most of the following illustrations I have used percentage figures to the nearest whole number.

The first illustration shows the distribution of the whole group of 500 cases using these Skeletal and Angle's classifications (*Fig.* 2).

The distribution of males and females was fairly even.

The Skeletal classification shows that there were nearly twice as many Sk. I patterns as Sk. II (Sk. I, 59 per cent; Sk. II, 32 per cent; Sk. III, 9 per cent).

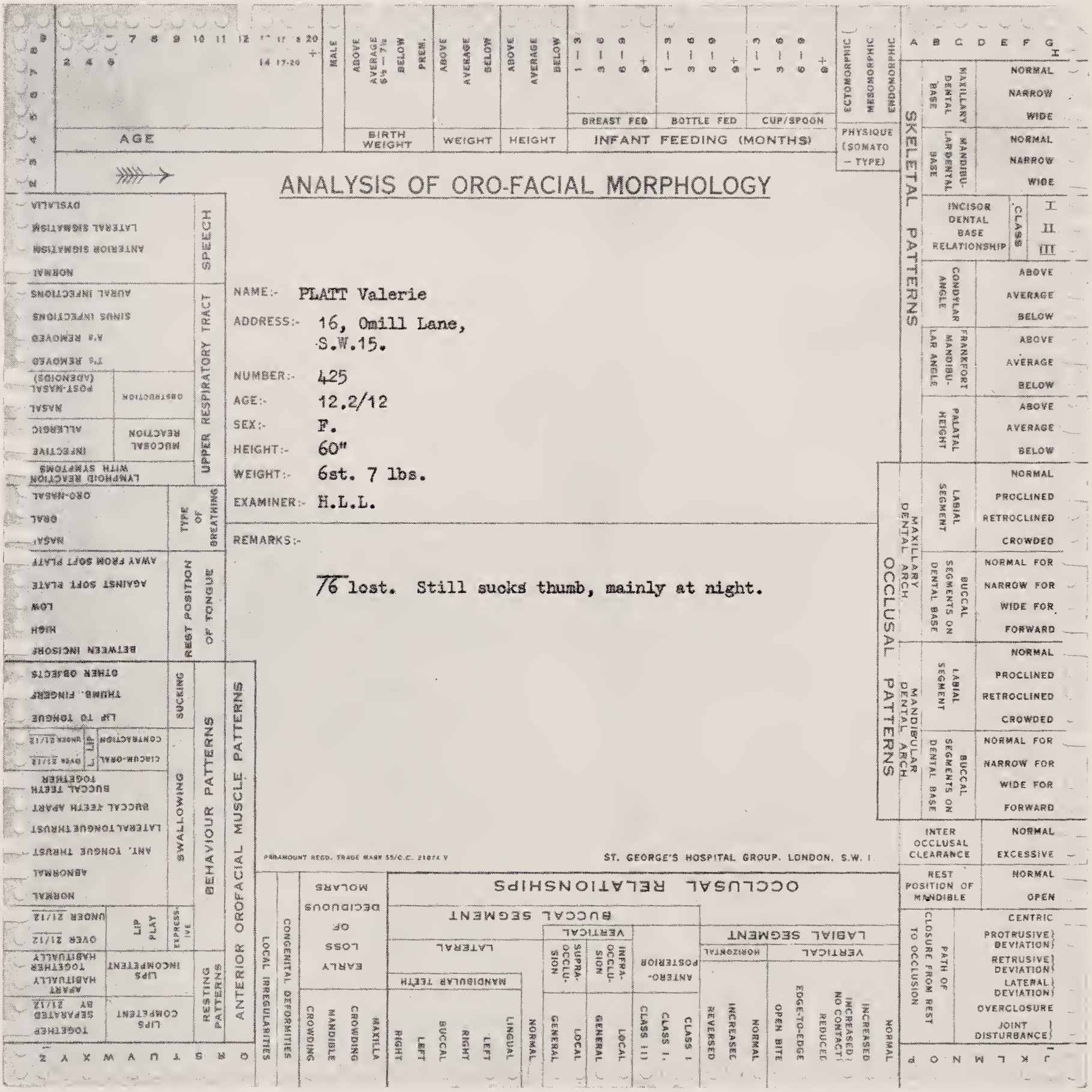

Fig. 1.—Showing a sample punch-hole card.

The average age of the patient is low, the majority having a mixed deciduous and permanent dentition; the oldest is 13 years, the youngest 2 years, and the average 7 years.

In the Angle's classification there were about twice as many Class I as Class II, division 1, and more than twice as many Class II, division 1 as Class II, division 2, or Class III (Cl. I,

56 per cent; Cl. II, div. 1, 26 per cent; Cl. II, div. 2, 10 per cent; Cl. III, 8 per cent).

Contrary to Wallis (1953), in his paper "Medical Aspects of Malocclusion", I did not find that the birth weights were lower in post-normal children but that they were similar to the Skeletal I group proportionately.

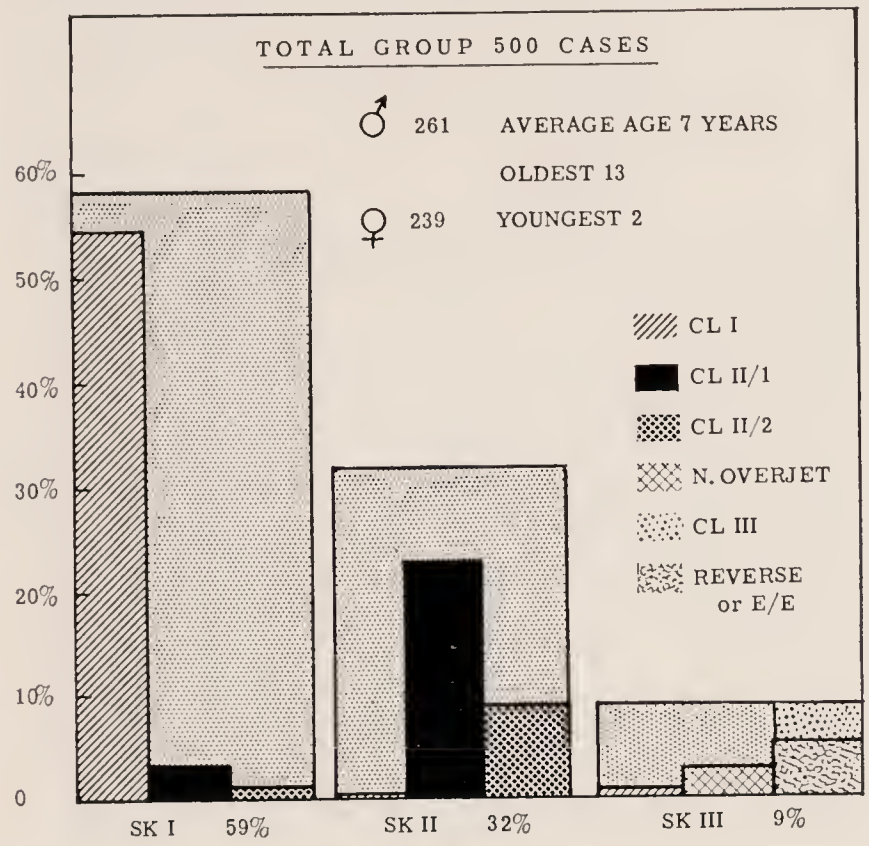

Fig. 2.

Of the 26 who were born prematurely (i.e., by international assessment birthweight $5\frac{1}{2}$ lb. or less), 18 were Sk. I, 7 Sk. II, and 1 Sk. III. Similarly I found little evidence that Sk. II children were weaned earlier as he states. At 6 months of age 52·2 per cent of the Sk. II had been weaned, compared with 50·5 per cent of the Sk. I and 47·8 per cent of Sk. III. This is in comparison to his 66 per cent Sk. II and 38 per cent controls. He suggests that "post-normality is associated with a general biological inferiority", basing his

			Per cent	
Sk. I	Cl. I	18		
	Cl. II, div. 1	2	4	
Sk. II	Cl. II, div. 1	14		
	Cl. II, div. 2	1	3	
Sk. III	Cl. III	2	→ 0·4	

Fig. 4.—Anterior interdental sigmatisms, 7·4 per cent (37 out of 500).

deductions on the figures for prematurity, infant feeding, enlarged tonsils and adenoids, etc. My figures do not agree with his, and to me his inference is unconvincing. Having an

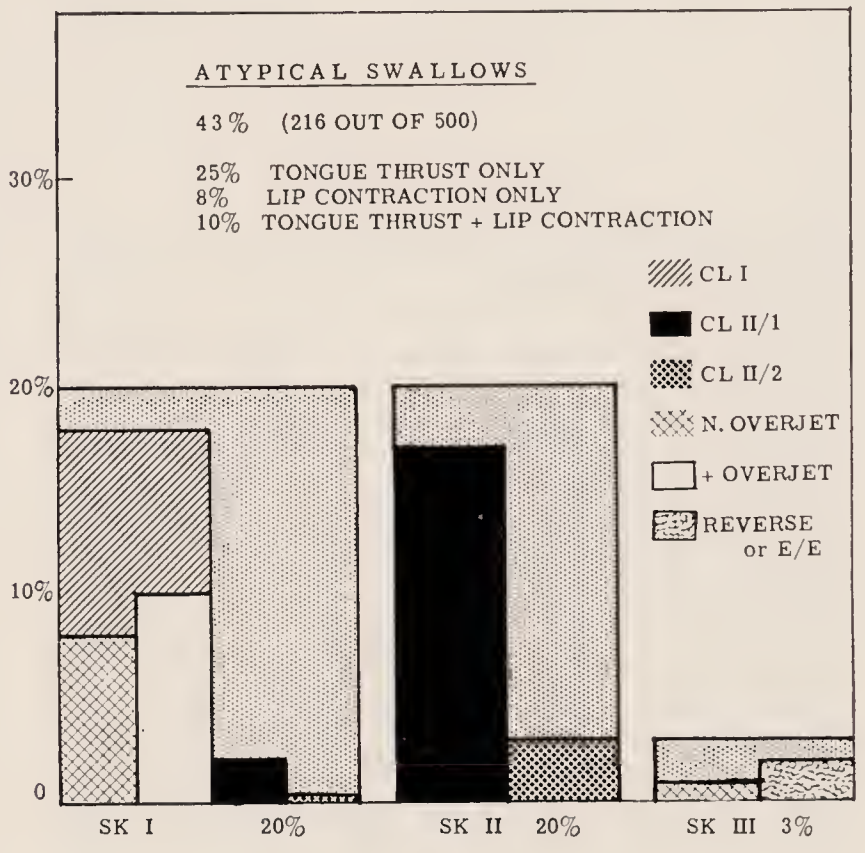

Fig. 3.

Angle's Class II, division 2 malocclusion myself, however, I may be biased!

Atypical Swallowing (*Fig.* 3).—Forty-three per cent of the total had some form of atypical swallow. This figure may seem rather high compared with that of 29 per cent found by Rix (1946), but the reason will become apparent later when the skeletal distribution is mentioned. This abnormality was defined as a contraction of the circumoral musculature with the lower lip passing either over or under the upper incisors, or a thrust of the tongue forward between the upper and lower incisors with the buccal teeth apart or in occlusion, or both lip contraction and tongue thrust.

There were 10 per cent with both a tongue thrust and circumoral contraction, 25 per cent with a tongue thrust alone, and 8 per cent with a circumoral contraction alone. Since there were as many atypical swallows on Sk. II bases as Sk. I (20 per cent), whereas in the total group of 500 there were only about half as many Sk. II as Sk. I, it appears that, proportionately, atypical swallows appear to be associated with Sk. II bases twice as much as with Sk. I. The Sk. I and Sk. III relationship

is practically the same in this atypical swallow group as in the total group. Looked at in another way, about one-third of the total number of Sk. I patients, two-thirds of the

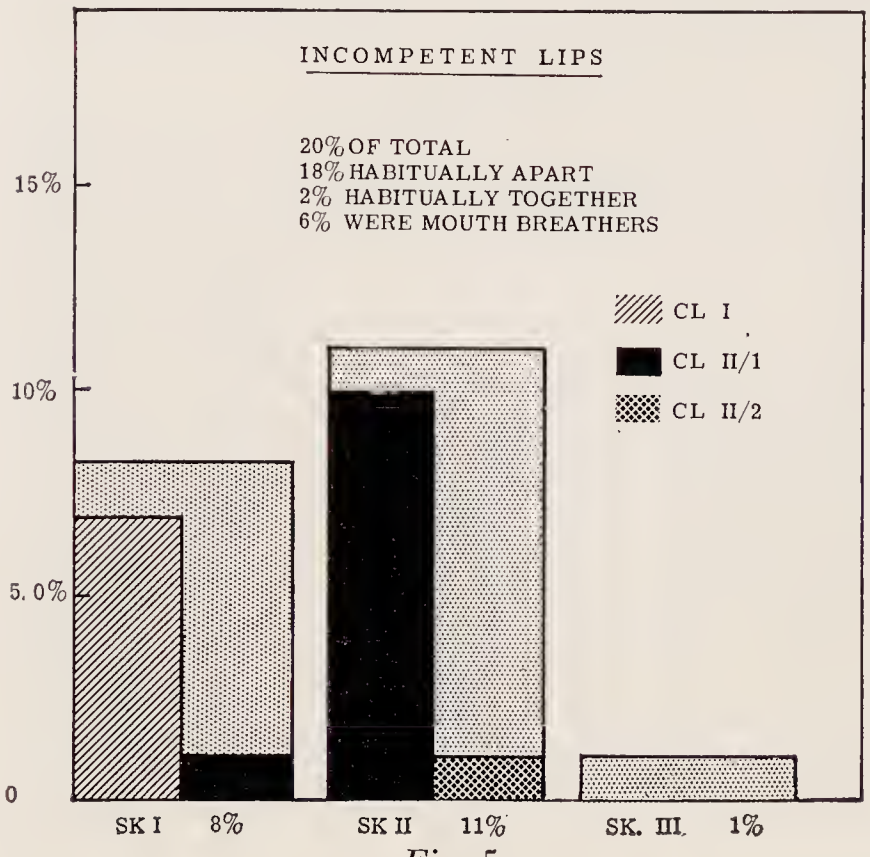

Fig. 5.

incompetent lips approximate them by contraction of the circumoral and mentalis muscles on swallowing. Consequently many of the abnormal soft-tissue behaviour patterns in these cases are most probably the result of the abnormal skeletal pattern, or at least merely an associated factor and not necessarily the cause of the malocclusion. The high figure is also most probably due to the fact that I have included in the group of abnormal swallows circumoral contraction alone without tongue thrusting.

Only on Sk. I bases can this abnormality of the soft tissue be the sole or main cause of an abnormal incisor relationship, which was an increased incisor overjet and reduced overbite or both, the tongue thrust and lip contraction enhancing one another.

On these Sk. I bases with atypical swallows, 61 per cent had an increased overjet and 31 per cent a reduced overbite.

Generally speaking, where the overjet was normal, the overbite was reduced; and where

Fig. 6.—Incompetent lips, showing the circumoral muscle contraction necessary to close them.

Sk. II, and one-third of the Sk. III had atypical swallows.

The reason for the large number of atypical swallows on Sk. II bases is most probably due to the fact that there are more incompetent lips associated with these post-normal bases (*see Fig.* 5) and that most people with the overbite was normal, the overjet increased. With premature loss of the deciduous molars in the lower jaw the retroclination of the lower incisors by the circumoral contraction appeared more marked.

In a few cases there was a Cl. II, div. 2 type of malocclusion with the circumoral

contraction retroclining both the upper and lower incisors, and yet a slightly increased overjet was maintained by the tongue thrust.

In an attempt to find a correlation between infant feeding and an atypical swallow, I noted the following:—

Of 94 out of the 500 (20 per cent) who were bottle-fed only, 43 had atypical swallows and 51 normal swallows, i.e., a fairly even distribution. There appeared, therefore, to be no direct evidence of a greater number of atypical swallows associated with lack of breast-feeding.

Anterior Interdental Sigmatisms (*Fig.* 4).—Thirty-seven of the 500 (just over 7 per cent of the total group) had an anterior interdental sigmatism or lisp (Sk. I, 4 per cent; Sk. II, 3 per cent; and Sk. III, 0·4 per cent). This shows a slightly higher proportion on Sk. II bases when these percentages are compared with the skeletal distribution of the total group of 500. Most of these patients had an associated tongue thrust and reduced incisor overbite, increased overjet, or both. Four patients with an interdental sigmatism had normal swallows and a normal incisor relationship.

Incompetent Lips (*Fig.* 5).—These may be defined as lips which failed to make an anterior oral seal in their rest or endogenous position (*Fig.* 6). Twenty per cent of the total had incompetent lips, but only 6 per cent of the total had incompetent lips and at the same time were actually mouth-breathing. In other words, less than one-third of those patients with their lips habitually apart were mouth-breathers, at least during the daytime. This was due, as explained by Gwynne-Evans and Ballard (1948), to the fact that although the anterior oral sphincter (the lips) was open, the posterior oral sphincter was closed by approximation of the soft palate with the base of the tongue. Mouth-breathing only ensued if there was an obstruction to a free nasal or post-nasal airway, in which case the tongue dropped away from the soft palate (*Fig.* 7). Removal of the obstruction resulted in a return to nasal breathing but the lips, of course, remained apart because they were basically incompetent.

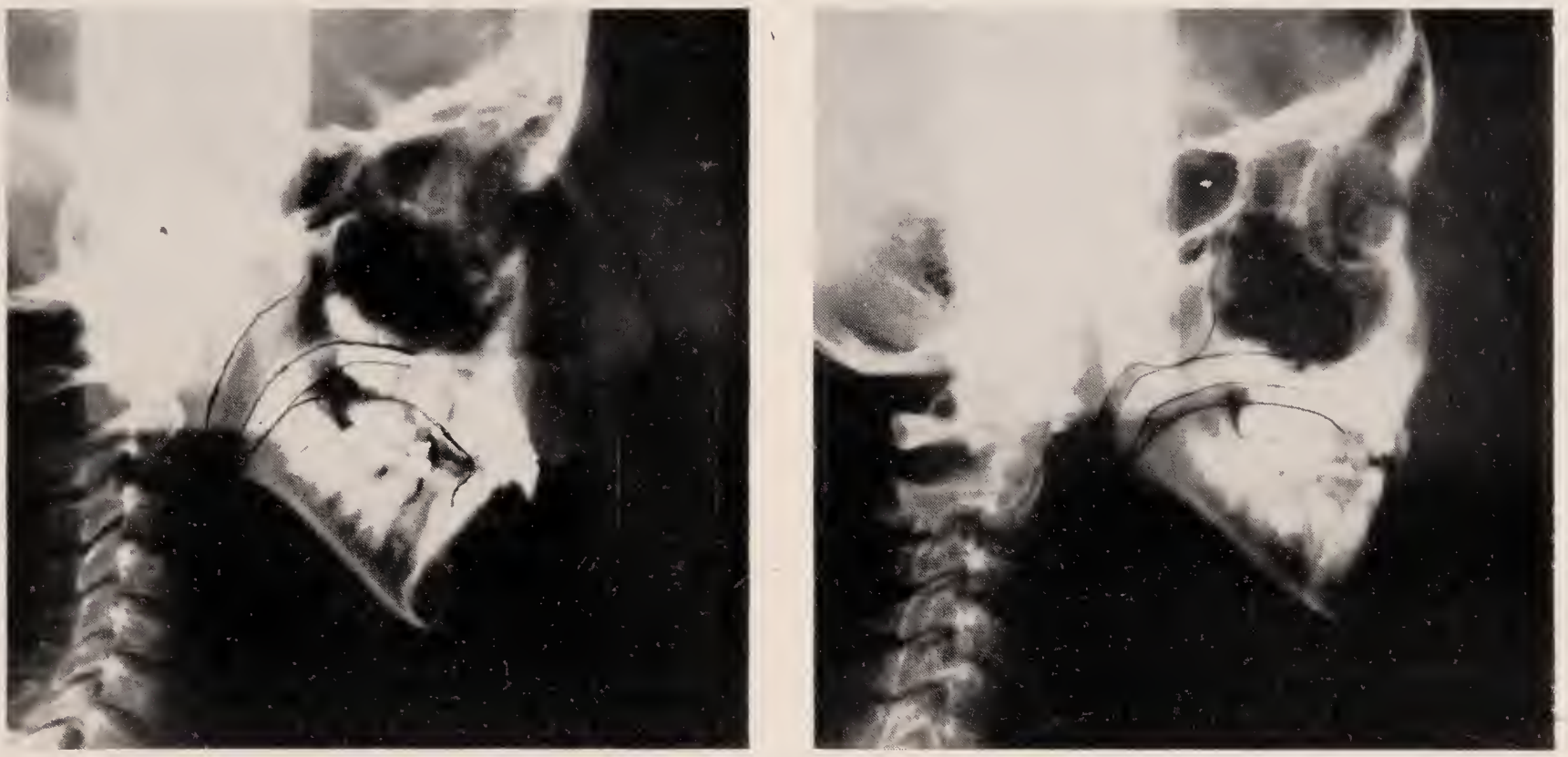

Fig. 7.—Showing a clear post-nasal airway with the tongue in contact with the soft palate, and an airway completely obstructed by adenoidal tissue with the tongue dropped away from the soft palate.

There were many more incompetent lips proportionately on Sk. II due to the post-normality of the dental bases and the associated discrepancy between skeletal and soft-tissue form (Sk. I, 8 per cent; Sk. II, 11 per cent; Sk. III, 1 per cent). This discrepancy may be in a vertical plane, anteroposterior plane, or both. Practically all those with this "lips apart" posture closed them on swallowing by circumoral contraction.

Tonsils and Adenoids (*Figs.* 8, 9).—Ninety-three per cent of the total group had hypertrophied tonsils or adenoids or both (60 per cent had large tonsils and adenoids, 31 per cent

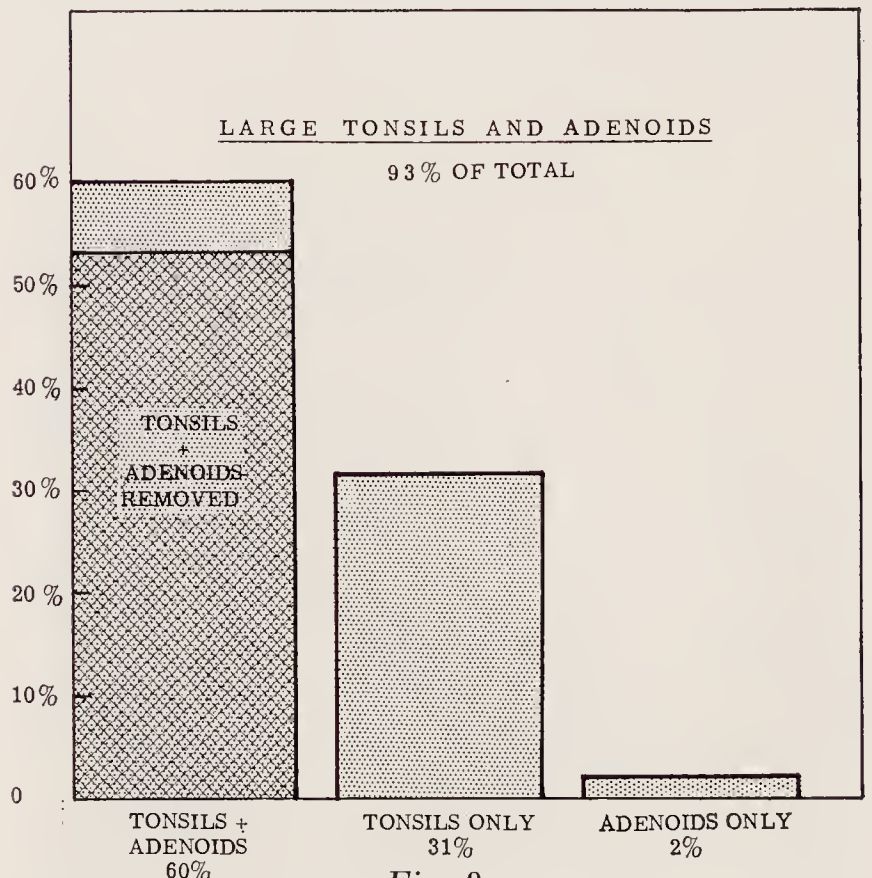

Fig. 8.

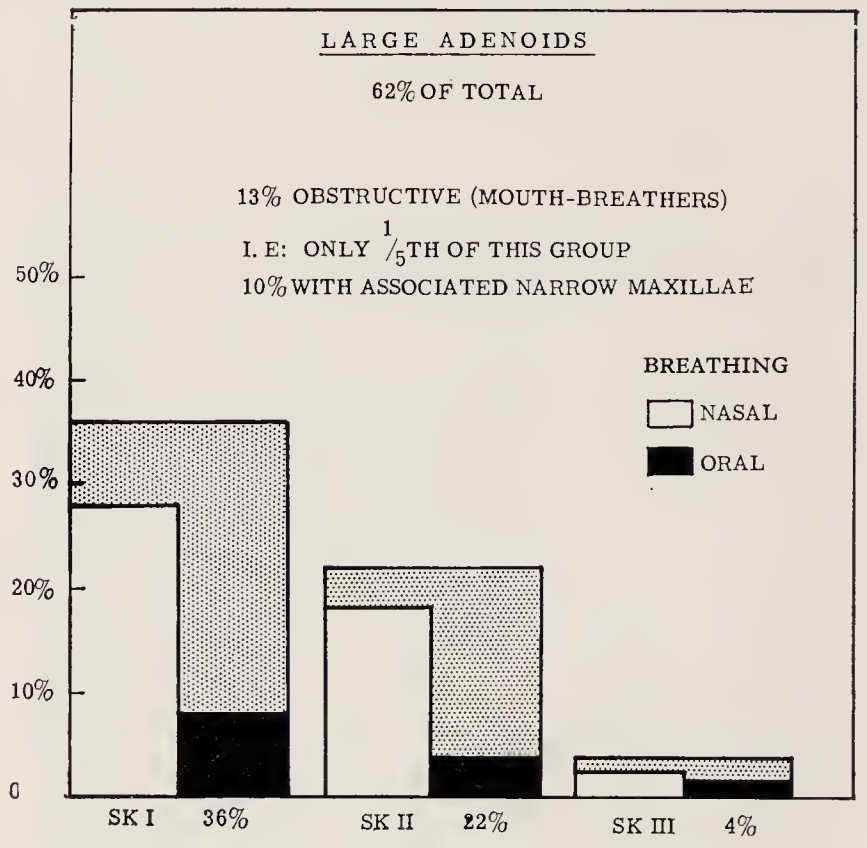

Fig. 9.

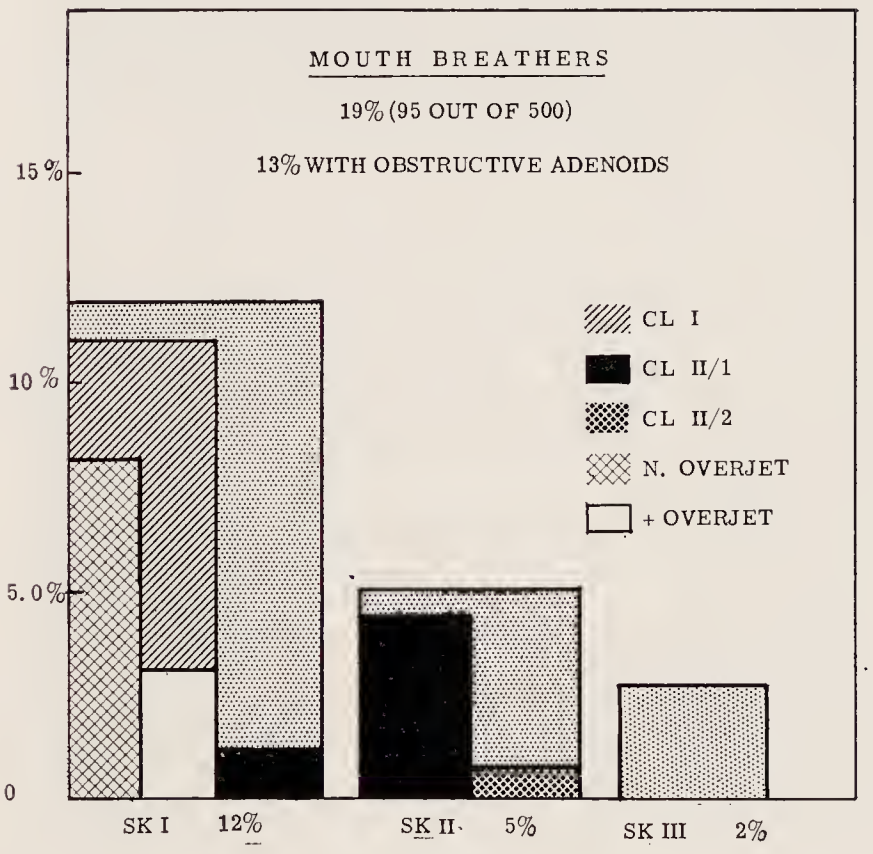

Fig. 10.

large tonsils only, and 2 per cent large adenoids only). This again may seem rather a high figure even for an ear, nose, and throat clinic. The tonsils were considered large if they extended beyond the boundaries of the pillars of the fauces, and the adenoids large if a definable soft-tissue shadow was present on a lateral skull radiograph. Physiological hyperplasia of the tonsils accounted for the enlargements in many cases and were not producing symptoms. Those that were both hypertrophied and giving rise to symptoms and subsequently removed were 56 per cent of the total of 500; or, put in a different way, about two-thirds of those with large tonsils or adenoids or both were operated on eventually. It was not the practice to remove tonsils and adenoids simply because they were large. In many cases a period of observation resulted in the cessation of symptoms and no surgery was indicated. Only if they themselves succumbed to infection and no longer served a useful purpose were they removed.

Coming to the debatable relationship between large adenoids and dental abnormalities, we find that of 62 per cent of the patients who had large adenoids 36 per cent were on Sk. I, 22 per cent on Sk. II, and 4 per cent on Sk. III bases. Adjusting our figures to relate these proportions with the incidence of Sk. I, II, and III in the total group of 500 we find that 61 per cent of the Sk. I's, 67 per cent of the Sk. II's, and 46 per cent of the Sk. III's had large adenoids. There was, therefore, a slightly higher proportion of large adenoids associated with Sk. II than with Sk. I or Sk. III. This proportion is small, and it would be unwise to suggest a cause-and-effect relationship between large adenoids

and the Sk. pattern. When the relationship is assessed with Angle's classification of the teeth themselves, we find the following: 60 per cent of Cl. I, 66 per cent of Cl. II, div. 1; 70 per cent Cl. II, div. 2, and 51 per cent of Cl. III with mouth, as described by Gwynne-Evans and Ballard (1948; 1957) (*Fig.* 11).

It will be seen that the relationship between the skeletal patterns amongst the mouth-breathers (Sk. I, 12 per cent; Sk. II, 5 per cent; Sk. III, 2 per cent) is virtually the same as for the total group; in other words mouth-breathing does not seem to affect the skeletal or occlusal pattern. The width of the jaws similarly is unaffected, as out of the 95 of the total group who had definitely narrow jaws only 18 were mouth-breathers.

Fig. 11.—Testing for nasal or mouth-breathing by noting the breath condensation on cold metal tongue spatulas.

large adenoids. This means that large adenoids are not the prerogative of Cl. II, div. 1 patients as is sometimes thought, but more if anything of Cl. II, div. 2.

Large adenoids are also considered by some to be associated with the lateral growth of the jaws, or rather the lack of it, but my figures show that only 10 per cent of those with large adenoids had definitely narrow maxillæ.

One other important factor of this group is that only one-fifth of these large adenoids so completely obstructed the post-nasal airway as to cause true mouth-breathing.

Mouth-breathing (*Fig.* 10).—Nineteen per cent of the total group of 500 were mouth-breathers. This is made up of 13 per cent which are due to obstructive adenoids, and another 6 per cent due to allergic and infective rhinitis, sinusitis, septal defects, etc. Those with temporary colds were of course excluded. The method of testing for mouth-breathing was to notice the condensation of the breath on two cold metal tongue spatulas, one placed under the nose, and the other in front of the

Allergic Rhinitis.—Sixteen per cent (80 out of 500) showed signs and symptoms of an allergic rhinitis but only 29 of these, i.e., just over one-third, of them were mouth-breathing.

There was no preponderance of an allergic rhinitis being associated with Sk. II, the skeletal and occlusal distribution being fairly similar to that of the total group of 500; if anything slightly more Sk. III, Cl. III (Sk. I, 9 per cent; Sk. II, 5 per cent; Sk. III, 2 per cent; Cl. I, 9 per cent; Cl. II, div. 1, 4 per cent; Cl. II, div. 2, 1·0 per cent; Cl. III, 2 per cent).

Anterior Open Bite (*Fig.* 12).—Twenty-one out of 500, i.e., approximately 4 per cent, had an anterior open bite and these were distributed on the skeletal pattern very similar to the total distribution (Sk. I, 2 per cent;

Sk. II, 1·6 per cent; Sk. III, 0·4 per cent). The age group was $3\frac{1}{2}$ to 8 years.

All had an atypical swallow with a tongue thrust and 9 out of the 21 an anterior interdental sigmatism. Just over one half were sucking a dummy or thumb at the time of

Sk. I	Cl. I	9
	Cl. II, div. 1	2
Sk. II	Cl. II, div. 1	8
Sk. III	Cl. III	2

Fig. 12.—Anterior open bite, 4 per cent (21 out of 500).

investigation. In many cases the tongue rested permanently between the upper and lower incisors and against the lower lip.

Support is given to the belief that anterior open bites are in most instances due to a form

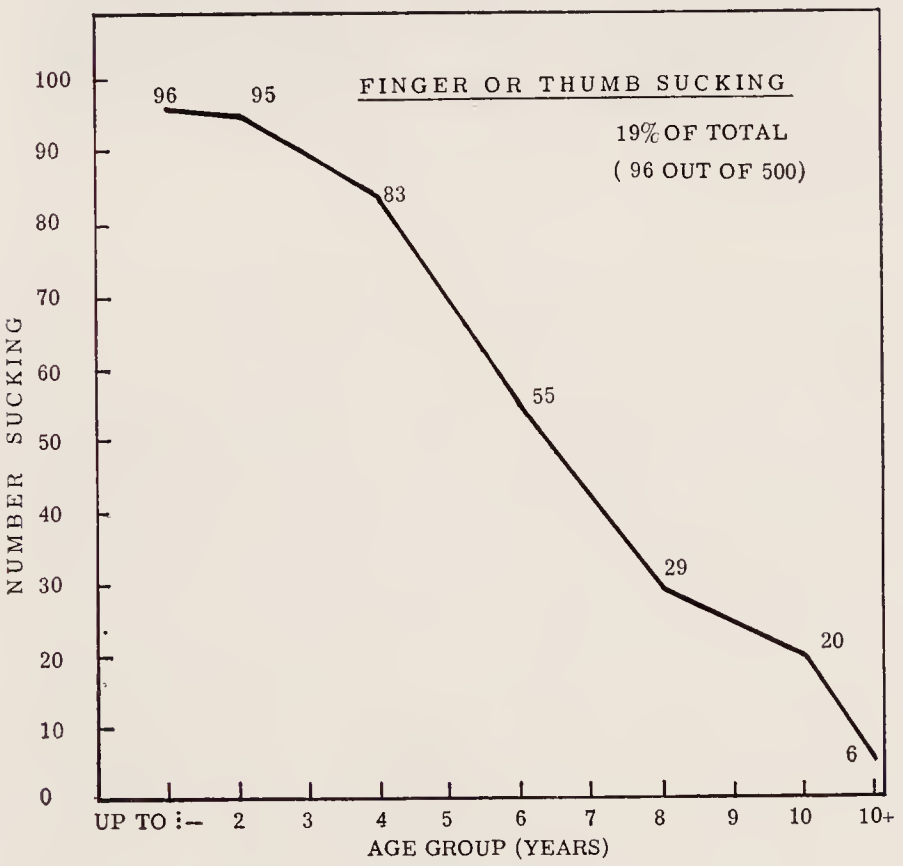

Fig. 13.

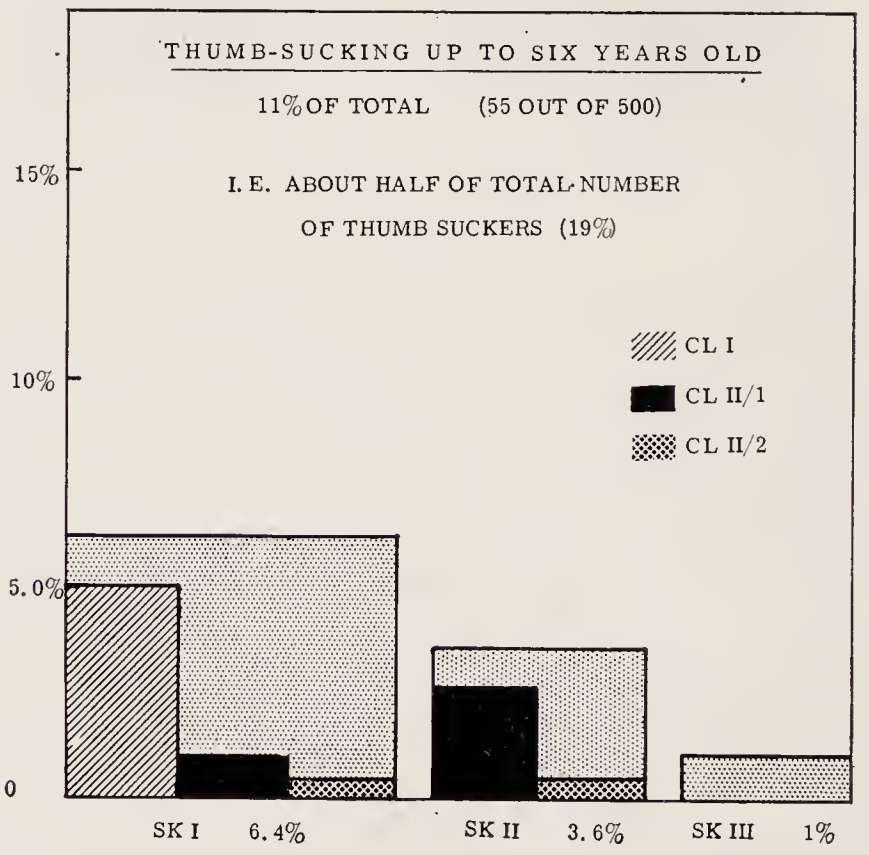

Fig. 14.

of obstruction to the vertical development of the incisors, be it dummy, thumb, tongue, or a combination of these factors.

Three of the 21 had no obvious obstructive causes but had a high Frankfort-mandibular plane angle, with a consequently much greater vertical height in the anterior than posterior region.

Thumb- and Finger-sucking (*Figs.* 13, 14).—Nineteen per cent (96 out of 500) sucked their fingers or thumb at some time or another. The average age for this group was 7 years, the eldest being 12 and the youngest 3, with a slightly higher proportion amongst the males. All but one had sucked for at least two years.

About one half were still sucking at 6 years of age. This is comparable to the figure of 11·2 per cent at 5 years of age given by Gardiner (1956) for his Sheffield schoolchildren. Roughly two-thirds had ceased at the time of eruption of the permanent incisors, i.e., about 6 per cent of the total of 500 were still sucking at 8 years of age.

The figures for those still sucking at 6 years of age were: Sk. I, 6·4 per cent; Sk. II, 3·6 per cent; Sk. III, 1 per cent; Cl. I, 5 per cent; Cl. II, div. 1, 4 per cent; Cl. II, div. 2, 1 per cent; Cl. III, 1 per cent.

Comparing these figures with the total group of 500 the ratio for the skeletal pattern is very similar to the total group, showing that the habit does *not* affect the skeletal pattern. The occlusion of the teeth is, as would be expected, affected with a proportionate preponderance of Cl. II, div. 1.

Of those of all ages still sucking, about two-thirds had a tongue thrust. On the Sk. I patterns 26 actually had normal swallows and 19 of them *normal* incisors.

If, as is suggested by these figures, thumb-sucking affects the occlusion only, the effect on the incisor relationship can only be truly

judged on the Sk. I patterns still sucking, of which there were 42. Here there were slightly more increased overjets than normal overjets (23 compared with 19) and a tendency for the overbite to be reduced (including 4 anterior open bites).

Out of this group of 42 still sucking, with a Sk. I base, 14 had a normal incisor relationship and 5 actually had an *increased* incisor overbite, but these latter had no tongue thrusts.

On the Sk. III pattern only 1 out of the 5 had a reverse overjet, suggesting that in these cases the habit tended to correct the incisor relationship.

Summing up, the habit seems to affect the occlusion only, not the skeletal pattern, and where the incisors are affected, there is nearly always an associated tongue thrust. Which plays the dominant role, the thumb or the tongue, I leave you to judge, but it is probable that they enhance one another. In the realm of malocclusion I personally would put thumb-sucking very low down in the aetiological scale. To quote Professor Ballard (1957 b): "inherited morphology of bone and soft tissue and the inherited or endogenous patterns of activity of the orofacial soft tissues are the causes of malocclusions, with habit posture and activities superimposed and confusing the diagnosis."

It is also interesting to reflect on the views expressed in a recent letter to the *British Medical Journal* by Mr. H. F. Welbourn of Kampala, Uganda, on patients attending the Welfare Clinic in Kampala who sucked their thumbs: "the deformity of the maxilla is far less often seen here than in Europe. Perhaps because the attitude of the African parent is more often one of condolence and amusement rather than of irritation and shame, African children tend to grow out of the habit more rapidly." Apart from the psychological effect of thumb-sucking the habit is apparently not free from superstition, as the Africans believe that a child who sucks his thumb will eventually kill his father, whereas one who sucks his fingers will grow up to be placid and content!

The relationship between thumb-sucking and feeding is shown by the following figures: Of 20 per cent of the total group of 500 who were bottle-fed only, 3 per cent were thumb-sucking, i.e., only about one-seventh of those who were bottle-fed only, sucked their thumbs. This seems to indicate no relationship between the habit and lack of breast-feeding.

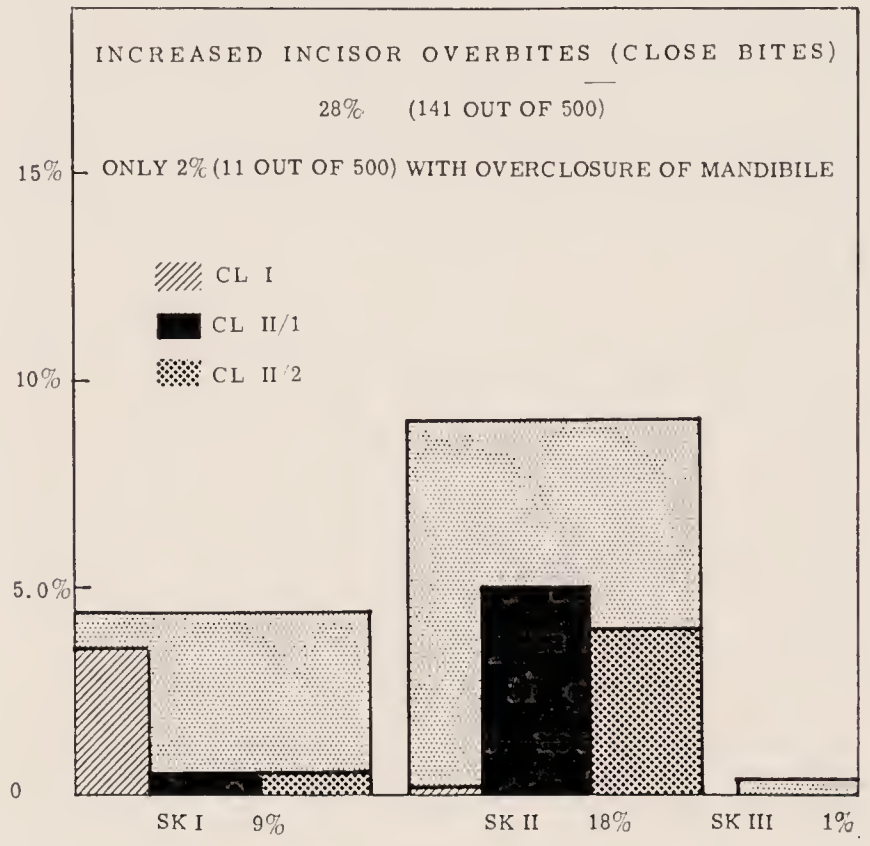

Fig. 15.

"Close Bites"—Increased Incisor Overbite (*Fig.* 15).—There were 28 per cent (141 out of the 500) with increased incisor overbites and these were distributed as follows:—

Sk. I, 9 per cent; Sk. II, 18 per cent; Sk. III, 1 per cent; Cl. I, 7 per cent; Cl. II, div. 1, 11 per cent; Cl. II, div. 2, 8 per cent; Cl. III, 1·5 per cent.

As will be seen, there are far more "close bites" on Sk. II bases, and compared with the total group of 500 distribution there are also far more on the Cl. II, div. 2 than on the Cl. II, div. 1 malocclusion.

In attempting to assess a true overclosure of the mandible to maxillæ on closure from the rest position to occlusion, the inter-occlusal clearance or freeway space was assessed using various methods of registering the rest position on endogenous mandibular posture as described by Ballard (1955).

The figure of 2 per cent only of the 500 with overclosure is low. In other words, only one-fourteenth of the increased incisor overbites showed an overclosure of the mandible from the rest to the occlusal position. Allowing for

a clinical error of as much as 50 per cent, this figure would still be very small.

Of these 11 overclosures, 6 were on Cl. II, div. 2, 3 on Cl. III, and 2 on Cl. I malocclusions.

There was a slight tendency for the Frankfort-mandibular plane angle to be low with increased and normal overbites and high with reduced overbites. This may be associated with a tendency for the lips to be more competent on low Frankfort-mandibular plane angles.

In contrast to the foregoing, 15 of the 141 with close bites sucked their thumbs and 9 were still sucking at the time of investigation!

Ballard (1957 a) has discussed the aetiology of "close bite" in detail in his Presidential Address to this Society, and the figures I have produced support his contentions.

Summing up it seems certain that most increased incisor overbites are *not* due to overclosure of the mandible (i.e., true close bites); they are due to an abnormal incisor relationship when either the upper or lower incisors or both are on a different occlusal level than the buccal teeth (where present), and the reasons for this have been fully discussed by Ballard (1957 a).

On Sk. I bases the altered axial inclination is due to an abnormal soft tissue behaviour, or possibly early loss of the deciduous teeth in the lower jaw, or both. The early loss in the lower jaw does not necessarily cause an overclosure but allows the lower incisors to become retroclined and lose their normal contact with the upper incisors. This is evident from the fact that early loss in the upper jaw does not result in a close bite (i.e., due to overclosure). On Sk. II bases the abnormal incisor relationship is due to the same causes as on Sk. I or, as is most likely, the post-normality of the skeletal bases, or both.

An abnormal incisor relationship will not necessarily give rise to a close bite if the tongue, thumb, or high Frankfort-mandibular angle prevents it.

It is possible to have an overclosure of the mandible (where there is a large freeway space) *without* a close bite (4 cases) if the incisor relationship is normal.

Acknowledgements.—I would like to thank first and foremost Professor Ballard and Mr. Gwynne-Evans for their help and encouragement in instigating and carrying out this work; the various photographic departments for the production of the slides; Mr. P. M. C. James who helped to compile the graphs; and finally, St. George's Hospital for their financial aid in the creation of this particular punch-hole card filing system.

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DISCUSSION

The Chairman asked Professor Ballard to open the discussion.

Professor Ballard thanked and congratulated Mr. Leech for producing such an interesting paper and collection of facts. Then he thanked him personally for spending so much time at Tite Street and for subsequently producing his analysis of the recordings.

The punch-hole card system which Mr. Leech had mentioned was produced after several years of discussion between Mr. Tulley, Mr. Gwynne-Evans, and Professor Ballard, with Mr. Walther coming in subsequently and Mr. Leech. The headings were the result of discussion and several years of clinical observation, and the exact meaning of all the headings had been defined.

The important thing about Mr. Leech's paper was that it had shown what had been suspected, that if one classified morphology correctly in relation to malocclusions and if one added to that classifications of various habit activities, in the end one would have a true perspective of the various factors in relation to the production of malocclusion.

Mr. Leech had said that he thought finger- and thumb-sucking was a very unimportant factor; that was a conclusion which had been arrived at by clinical observation, but figures such as those produced by Mr. Leech were necessary before one could in fact be sure of one's observations. Mr. Leech's figures supported the view that most of the malocclusions were the result of inherited variations and that external factors only tended to add to the diagnostic problem; that finger- and thumb-sucking only tended to increase an abnormality which had been there already.

As he had mentioned, Mr. Leech's figures on finger- and thumb-sucking were the same as Gardiner's. In a statistical analysis by people such as Gardiner and in a study on infants by Lehrner (1955) one did not find

support for finger- and thumb-sucking as an aetiological factor, and he thought most of the statements had arisen in the past from a purely subjective approach. Mr. Leech had asked which played the prominent part, the thumb or the tongue, and in this respect it was interesting that he found that 15 out of 141 with an excessive overbite sucked their thumbs. This might suggest that in fact, as previously stated, it was the tongue-thrusting which was the important factor in anterior open bite when tongue and thumb were associated. It was known from a serial study of infants that both with finger- and thumb-sucking, and particularly with tongue thrusting, as the dento-alveolar structures develop into a larger maxillary space the influence of finger- and thumb-sucking has less effect on those alveolar structures. That has led to people concluding that their treatments to control finger- and thumb-sucking had in fact produced improvement in malocclusion, but the serial studies had shown that that would have taken place anyway.

With regard to bottle feeding, Friel in 1948 studied serially children who had been cup fed from birth. The interesting thing was that the cup-fed infants were psychologically more stable than some of the breast-fed children, and at the end of ten years they showed no dental abnormalities.

On the relationship between overclosure and close bites, he suggested that the figure of 2 per cent only of the 500 showing overclosure was not low, as Mr. Leech suggested, but high. He would have liked to discuss this with Mr. Leech before. He used to find a fairly high percentage, 2 or 3 per cent, of cases in which he would say there was an overclosure, and he thought he was making the error of not assessing for the endogenous postural position. In other cases many may have tongue to lower lip activity, and most of those cases if there was increased overjet also pushed the mandible downwards and forwards, so apparently showing an increased interocclusal clearance.

He was sorry that Mr. Leech did not see Dr. Wallis's point because he thought it was a reasonable conclusion to reach. He suggested that the type of Class II mentioned by Dr. Wallis was not in fact the post-normality that Mr. Leech had mentioned. Mr. Leech had said that Dr. Wallis found his post-normal cases were taller. Dr. Wallis's cases were probably Class II, division 1 cases.

Professor Ballard felt fairly confident that Mr. Leech could not prove one statement he had made, but it was a minor point. He had said that with the premature loss of the deciduous molars in the lower jaw the retroclination of the lower incisors by the circumoral contraction was more marked. Professor Ballard had already pointed out that he thought there was a limit to the degree of collapse following early loss of deciduous teeth. He suggested the retroclination of the lower incisors, as Mr. Leech had classified it, in association with circumoral contraction was not a collapse of the segment secondary to early loss but in fact was retroclined lower segment initially as a result of the circumoral contraction which enhanced the anteroposterior crowding in the arch. In other words, he did not think a collapse like that was of the order of more than about 4° of change of axial inclination. It was only by serial study that one could check that there was a possible error of observation of that kind.

In conclusion Professor Ballard said he would again like to congratulate Mr. Leech. An investigation with a slightly different classification had to be done with very much larger numbers. He hoped that perhaps the Royal Dental Hospital would do something of the sort.

The Chairman asked Mr. Gwynne-Evans to continue the discussion.

Mr. Gwynne-Evans said he was only going to generalize for a moment or two and to add to what Professor Ballard had already said in opening the discussion.

As the members would know, the Upper Respiratory Clinic was composed of three specialities—rhinology, orthodontics, and speech therapy. No one would know more than he the difficulties that Mr. Leech had to surmount in drawing up and interpreting a definite inquiry into the relationship of so many variable factors. It had given him no small degree of satisfaction to see produced the conclusive results of this united endeavour.

He thanked Mr. Leech for the patience and time he had given to this Clinic and for preparing such an enlightening paper. Whether other workers would agree with his figures or his conclusions mattered little at this stage. What mattered was the method that was being used to unravel in an orderly manner the tangle of associated factors which were not necessarily interdependent. In the past, wrong correlations had led to wrong assumptions, and the method of analysis demonstrated should go far to prove or disprove many time-honoured cause–effect relationships. He would like to see the punch-hole card, which they had taken so much trouble to design, used by other hospitals and schools because a comparison of findings by different workers using the same method of analysis should lead us very near to the truth.

The Chairman opened the paper for general discussion.

Mr. W. J. Tulley said he thought the paper justified the Jubilee Meeting and was a turning point in the history of the Society because he had produced proof of something they had all been hearing of for quite a long time, and that some people were still disbelieving. He hoped that Mr. Leech had gone a long way to converting them.

With regard to the figure of 4 per cent open bite, he gathered negative overbite had been meant and not the number with no lower to upper incisor contact. Then he asked if he had heard correctly that Mr. Leech had defined incompetent lips as those which could not effect a seal at rest. He would not define lips as incompetent if they could not effect a seal at rest because interposed teeth were merely stopping their contact.

Mr. J. H. Hovell endorsed all that Mr. Tulley had said about the value of the paper. There were just one or two points he wished to mention.

There was a difference between Mr. Leech's figures on atypical swallowing and those produced by Rix; his figures were somewhat higher, and he did not offer a convincing explanation. There were two points on which he would like to hear Mr. Leech's comments: the first was the possibility of there being some unexplained connexion between atypical swallowing and respiratory disease, and the other was the method of assessing atypical swallowing, which Mr. Hovell had found very difficult. If one actually told a patient to swallow one would get an atypical swallow from a patient who normally swallowed in quite a normal way, not in an atypical way. The other point was the contraction of the lip when one had an incompetent lip morphology.

A point which was very important was that the figures had been taken from the Upper Respiratory

Clinic and not from a large cross-section of the population. One might think, therefore, that there would be an abnormally large number of mouth-breathers. In an orthodontic clinic as opposed to a respiratory clinic the amounts would be much smaller than those given by Mr. Leech, and he had not said how many mouth-breathers had competent lips. Mr. Hovell did not think the condition of the lips had anything to do with mouth-breathing ; he thought people breathed through their mouths because they had an obstruction to the nasal respiration, and they could get that with competent lips. In order to assess the competence of lips in a child who breathed through its mouth, the child had to stop breathing for a period.

Professor Ballard had made a point about Mr. Leeeh's assessment of overclosure, and Mr. Hovell also thought his assessment of overclosure was high rather than low. He would put it very much lower.

Mr. W. A. Nicol thanked Mr. Leech very much for his paper. He did not wish to imply any criticism of the paper as such, but he did think it would be of value to many members who were not immersed in this type of work if in a paper of this description, which was purely statistical, they could have some prior notice of the figures, perhaps with the Notice convening the Meeting.

With regard to the differences with Dr. Wallis's work, Mr. Nicol pointed out that Dr. Wallis's work had been done on a pure random sample, a sample of school-children as they came up for medical examination. Some of the differences may be accounted for in that way.

Mr. J. S. Beresford said that it would be helpful if Mr. Leech could give a good definition of "competent" and "incompetent" and also, perhaps, "endogenous postural position". Could that not be changed a little, he wondered, because to him "postural" and "position" meant almost the same thing. Mr. Beresford said he could not do it, but he felt sure Mr. Leech could.

The Chairman said that he had asked on many occasions for someone to define competent lips and he had been astonished to hear Mr. Leech define it in the way he did.

Going round hospitals he had come into contact with a number of E.N.T. surgeons who had varying ideas on mouth-breathing. Some of them frequently sent patients asking for them to be provided with oral screens to prevent them from breathing through their mouths. Others state that patients breathe through their mouths only if they are prevented by obstruction from breathing through the nose. The condition of the mucous membrane might vary from time to time or even from room to room, so that although the nasal passages were clear one minute they might be obstructed shortly afterwards. They deprecated oral screens.

Mr. Leech thanked Professor Ballard and Mr. Gwynne-Evans for their remarks and for opening the discussion on his paper. He did not think there was really anything which they had said to which he needed to reply.

In reply to Mr. Tulley on the point of normal occlusion, he said he had seen very few indeed with true normal occlusion, but it depended upon one's assessment of "normal occlusion" and "malocclusion", the degree to which the teeth had to be out of relationship with one another to be in malocclusion. He had tended to classify many of them as Class I, in actual fact there were very few who were really in true normal occlusion.

The open bite was a very difficult thing to assess, even with measuring the occlusal plane, but he put those cases into the category of open bite if there was not just a reduced overbite or an edge-to-edge bite but less than an edge-to-edge bite.

As one could see, the difficulty with the punch-hole card system was to define all the various types of irregularity. It was very difficult to get a definition and they had had much difficulty agreeing even among themselves what was the definition, for example, of competent lips. Mr. Leech did not know that he could give a really satisfactory definition of incompetent lips. He had said that these were defined as lips which failed to make an anterior-oral seal in their rest position. He would say that competent lips were those which were in contact with each other in the normal rest position of the lips, that is to say with no obvious contraction of the circumoral muscles, and with the mandible in its endogenous postural position.

Mr. Hovell had asked about the rclationship between the abnormal swallow and E.N.T. disorders. Mr. Leech said he would not like to commit himself on that at all. Whether there was a lack of post-nasal drainage in people with an abnormal swallow or not he thought was very difficult to assess. He had stated his assessment of the abnormal swallow and produced his figures for his own assessment, but that may not be in agreement with someone else's assessment for abnormal swallow. He had mentioned two main things, the thrust of the tongue and the contraction of the lips, and in drawing up the punch-hole card system that presented quite a lot of difficulty. Eventually, under the behaviour patterns, the following items had been put down under the heading of swallowing: Normal, abnormal, anterior tongue thrust, lateral tongue thrust, buccal teeth apart, buccal teeth together. If one asked one patient to swallow it might be a patient who would make "quite a meal of it" whereas another might have a very slight contraction of the lips and a very slight tongue thrust, which would hardly be classified as abnormal at all. There were, of course, various degrees of abnormality between these two extremes. It would be impossible to lay down a hard-and-fast rule for an abnormal swallow. He thought he had perhaps erred a little on the high side. He always looked at the soft tissue behaviour as soon as the patient sat down in the chair and while he was asking for the age and so on, never making the patient conscious of the fact that he was looking at the teeth. One advantage of working in an E.N.T. clinic was that the patients did not know what the orthodontist was looking for!

Mr. Leech was sorry he had not produced figures for competent lips in mouth-breathers; he had the figures but he had not managed to get them collated, but he said he would produce them, perhaps in the form of another short communication.

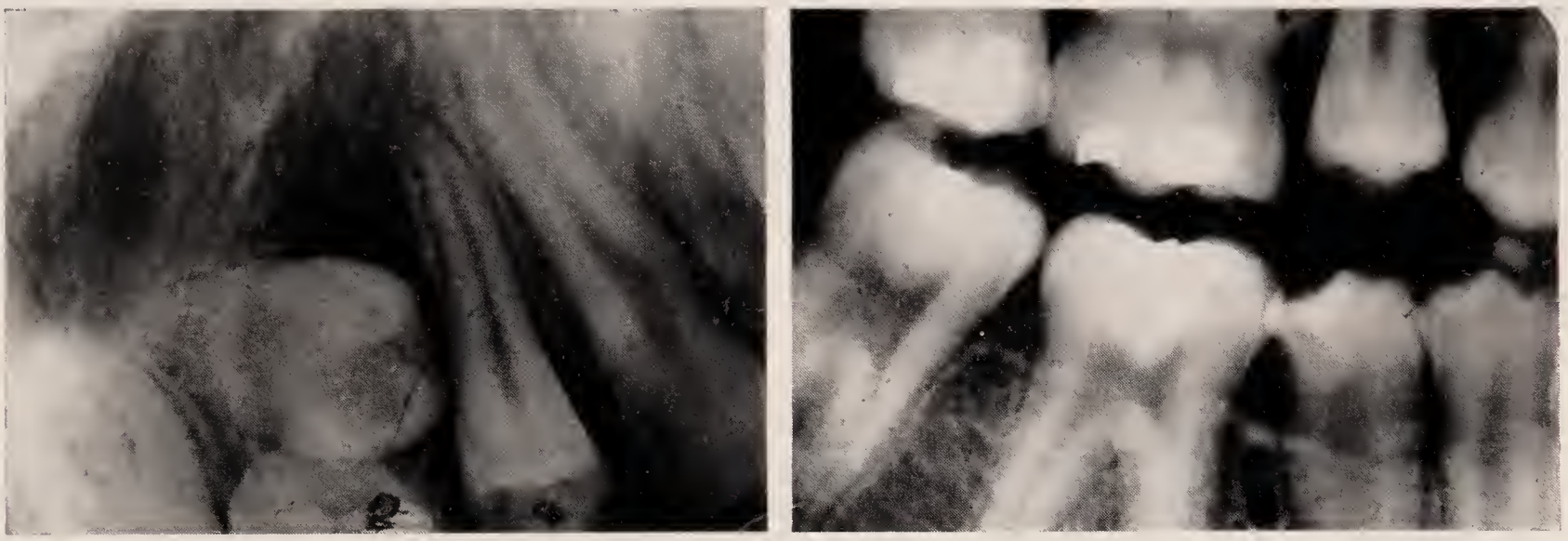
He thanked Mr. Nicol and Mr. Oliver for their remarks, and also Mr. Beresford. He thought he had answered all the questions included in their remarks, and also the Chairman's.

The Chairman said that everyone associated with Mr. Leech knew the meticulous care with which he dealt with any problems, whether in regard to the work of the Society, clinical work, or for the preparation of a paper. Statistical papers were often thought of as being very dull, and it said a great deal for Mr. Leech that his had been instructive, interesting, and amusing.

ATYPICAL PATHS OF ERUPTION: SOME CAUSES AND EFFECTS

By **J. S. ROSE**, B.D.S., F.D.S., D.Orth. R.C.S.

THE problem of eruption is a difficult one because there is no really satisfactory explanation of the process. Though there have been many theories concerning eruption, the only point of agreement would appear to be that there is some mechanism that causes a tooth to move from its developmental position to its position of occlusion. Whatever this mechanism is, it would seem to have considerable force on some occasions. For instance, in 1952 Wilson showed two cases where second premolar spaces had been completely re-opened, apparently by the erupting tooth forcing its way between the first premolar and the first molar. Again, the crowns of erupting teeth may come into contact with roots of already erupted teeth, and cause their displacement, and sometimes even their resorption. I think root resorption is more likely to occur if the tooth being pressed on is not free to move. The displacement of an upper second incisor by the developing canine is an obvious example of this. But if the crowding is tight enough to prevent the lateral from moving, then pressure from the canine may cause resorption of the incisor root. If a deciduous tooth is being resorbed, then pressure on its root from a successional tooth may well hasten the process. Occasionally the developing premolar lies obliquely between the roots of the deciduous tooth. In this case, during eruption more pressure will be placed upon one of the roots and this one will resorb more rapidly.



A B

Fig. 1.—Self-correction of $\underline{5}|$ after extraction of retained $\underline{E}|$.

Fig. 2.—$|\overline{6}$ lost. Resorption of the distal root of $|\overline{E}$ allowing $|\overline{5}$ to move distally.

A given force is said to have magnitude and direction. If there is a force of eruption, then it is necessary for there to be control of the direction of that force. Assuming that a tooth is in its normal developmental position, we know that it will erupt towards the surface; and that once it has broken the surface it will continue on its path until it reaches some form of opposition. When a tooth has erupted into

Given at the Jubilee Meeting held on May 10, 1957.

the oral cavity it will come under the directional control of the adjacent teeth and soft tissues, and thus be guided into a position of stability, where it will stay unless its environment is changed. It is that change of normal environment and its effect on the direction of eruption with which I am concerned in this paper.

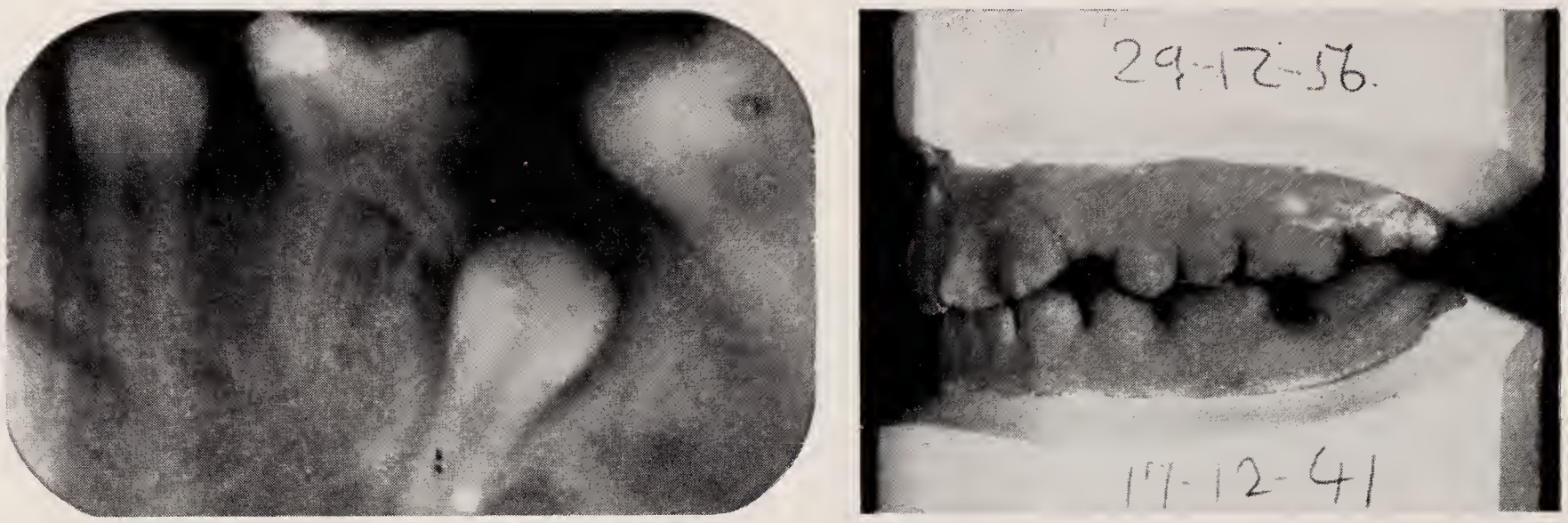


Fig. 3.—$|\overline{6}$ lost. $|\overline{E}$ retained. $|\overline{5}$ travelling distally.

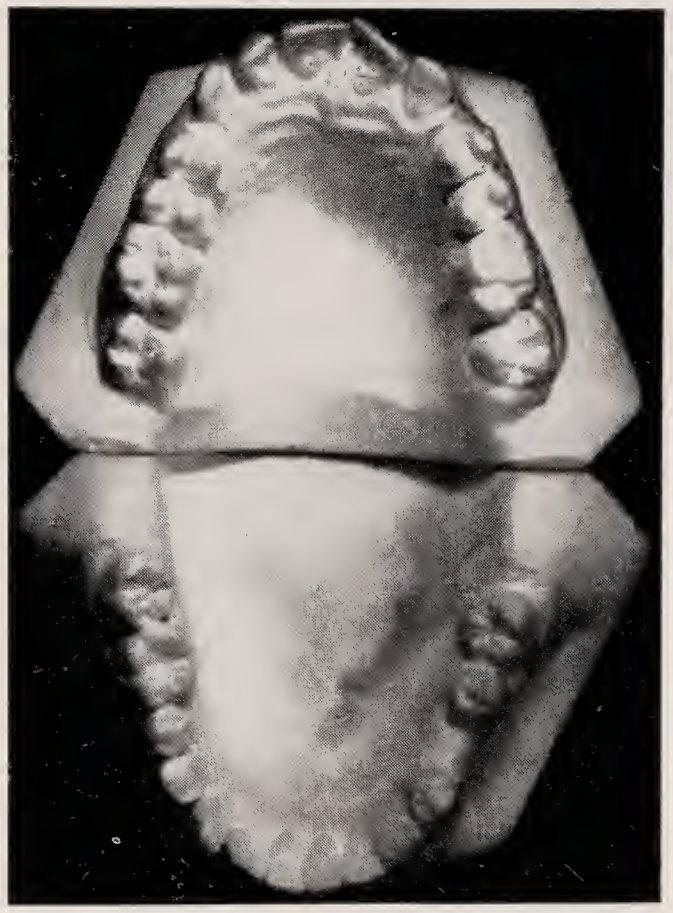


Fig. 4.—The same case as *Fig.* 3 after extraction of $|\overline{E}$. $|\overline{5}$ has erupted into contact with $|\overline{7}$.

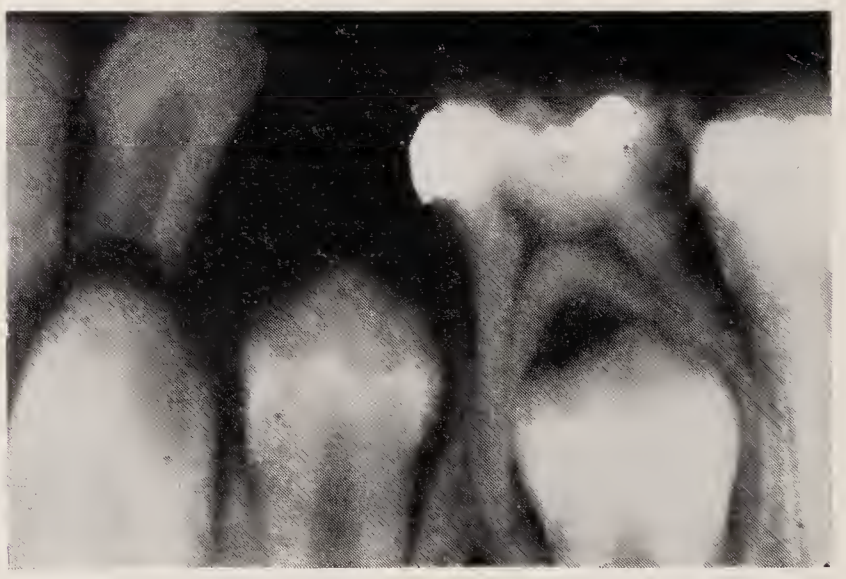


Fig. 5.—$\overline{4}|$ has been extracted. The mesial root of $\overline{E}|$ has resorbed. $\overline{5}|$ is moving mesial to $\overline{E}|$. Note the uneven resorption of the roots of $\overline{E}|$.

Fig. 6.—|6 has been extracted. |5 is erupting distal to the retained |E.

It is well known that a retained deciduous incisor will cause an erupting successor to change its path and come into a position of lingual occlusion. This is, of course, a simple example of change in environment surrounding the erupting tooth, and because of this the normal guiding forces cannot exert their anticipated influences. The result is a local malocclusion.

A very similar picture would appear to take place within the alveolus. Normally a developing premolar will be found between the roots of its deciduous predecessor. These roots will serve to guide the successional tooth towards the alveolar surface, so long as they resorb relatively evenly, and so long as the contiguous teeth are in normal positions. Within

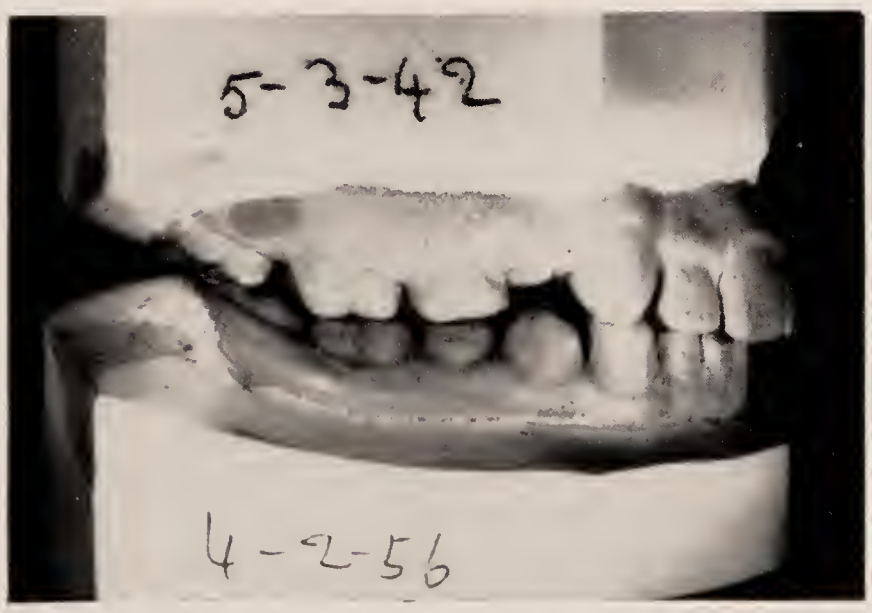


Fig. 7.—4|4 have been enucleated. E|E are retained and 5|5 are erupting into 4|4 spaces.

these limits considerable self-correction of a misplaced tooth is possible. For example, *Fig.* 1 A shows a misplaced 5| with a retained E| in a boy nearly 15 years old. The deciduous tooth was extracted and its space maintained.

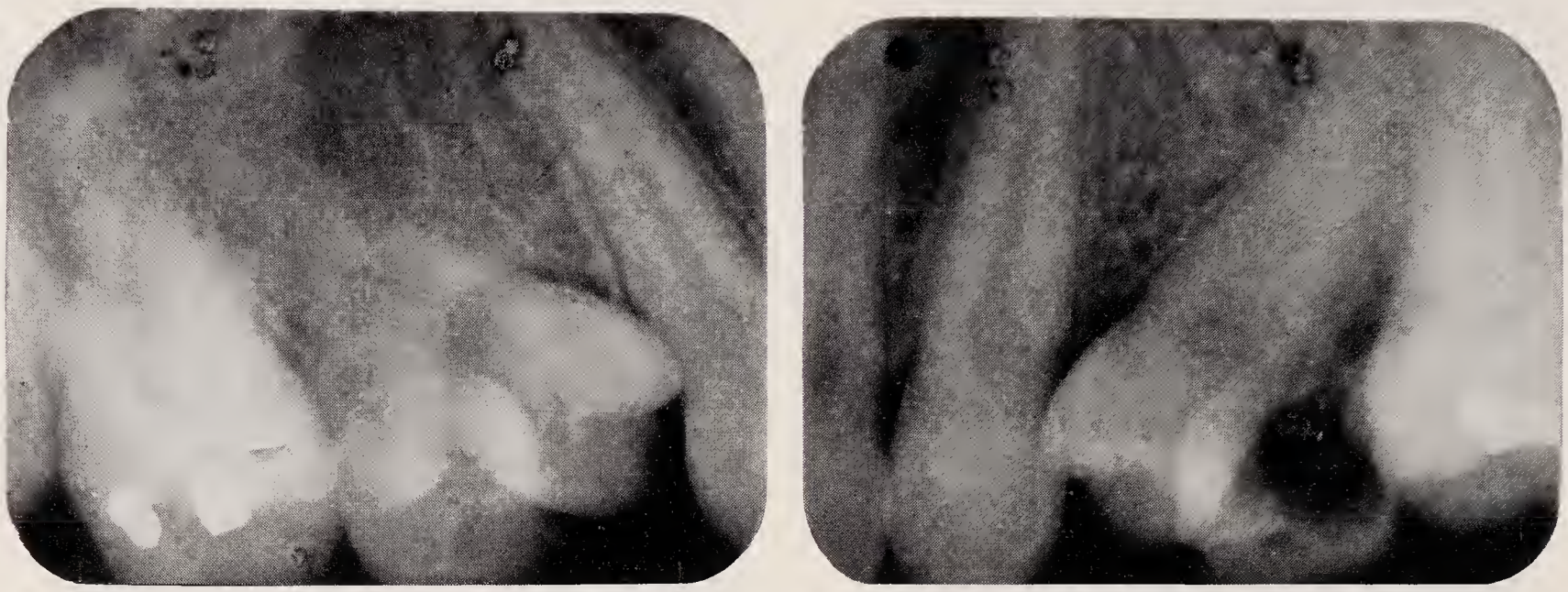


Fig. 8.—Radiographs of *Fig.* 7.

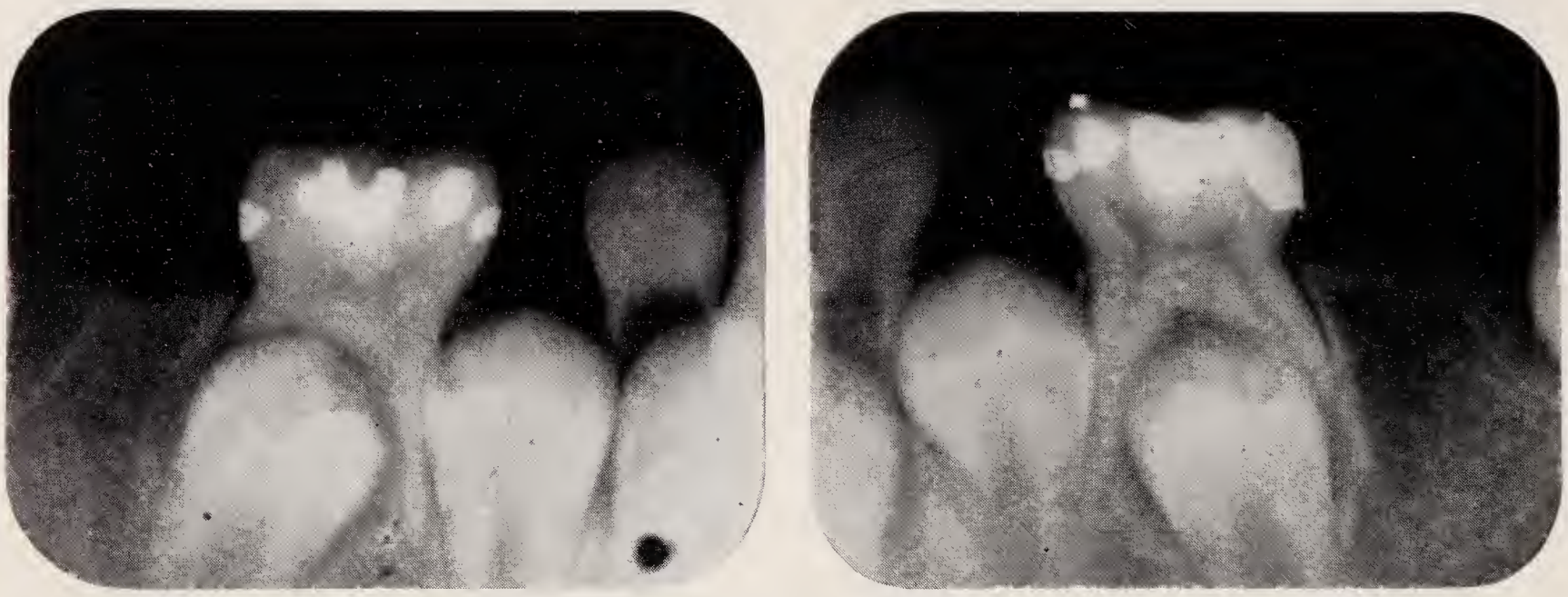


Fig. 9.—Radiographs of both sides of a case which had lost $\overline{6|6}$. Note uneven resorption of the roots of $\overline{E}|$ and relatively even resorption of the roots of $|\overline{E}$.

Five months later, the premolar is shown to be erupting in a normal position (*Fig.* 1 B). It is worth noting that the premolar, being smaller than its predecessor, had room to manœuvre into a normal position. And it is reasonable to assume that the adjacent teeth acted as guide planes for its path of eruption, allowing the premolar to follow the direction of minimum resistance. In practice we take advantage of guide planes when trimming a monobloc, to encourage a tooth to follow a predetermined path.

The problem of atypical paths of eruption would appear to arise when the normal environment of guide planes is somehow changed. If one accepts that a tooth will erupt along the path of least resistance, then if one can lessen the resistance in a particular direction the path of eruption can be anticipated. In *Fig.* 2 there has been early loss of $|\overline{6}$, and the distal root of $|\overline{E}$ has been resorbed. As a result $|\overline{5}$ will probably erupt distally to $|\overline{E}$. *Fig.* 3 shows a similar picture one stage further, and *Fig.* 4 shows $|\overline{5}$ erupted in contact with $|\overline{7}$, after removal of $|\overline{E}$. The same process can happen in a mesial direction. *Fig.* 5 shows $\overline{5}|$ slipping forward under $\overline{E}|$, following the earlier extraction of $\overline{4}|$. The opposite side shows the distal root of $|\overline{E}$ being resorbed more rapidly than its mesial root. If the $|\overline{6}$ had been extracted, the $|\overline{5}$ may well have moved distally.

A corresponding picture can be found in the upper arch. In *Fig.* 6, $\underline{|5}$ can be seen erupting distal to $\underline{|E}$ subsequent to the early loss of $\underline{|6}$. The next case has a previous history of having had $\underline{D|D}$ extracted and $\underline{4|4}$ enucleated at the same time, to treat maxillary crowding. About two years later, when I first saw her, the patient had $\underline{5|5}$ erupting into $\underline{4|4}$ spaces, and $\underline{E|E}$ still retained, as shown in *Figs.* 7 and 8. In 1948 Michaelis showed a similar case, in which the condition occurred unilaterally.

However, these effects do not occur each time one extracts a first premolar or first permanent molar. *Fig.* 9 shows radiographs of the two sides of a case that had lost $\overline{6|6}$. On the right there has been resorption of the distal root of $\overline{E|}$, and $\overline{5|}$ is beginning to move distally; on the other side there is relatively even resorption of the roots of $\overline{|E}$. The only explanation that I can offer for this change of environment is that resorption of the deciduous root nearest to the site of the extraction will be hastened where there has been infection in the socket either before or after extraction, or where there has been trauma at the time of extraction. Either of these effects would set up an irritant inflammatory reaction in the area, and this might accelerate the resorptive processes. A further danger would be if the developing premolar had a distal inclination. Once it had broken through the distal root of the second deciduous molar, there would be nothing to guide it back on its proper path (*see Figs.* 3 and 4). These points might well be considered when extractions of the four first permanent molars are contemplated.

There is another point of interest in regard to the atypical paths of eruption of premolars. Friel (1945) has said that "all teeth move

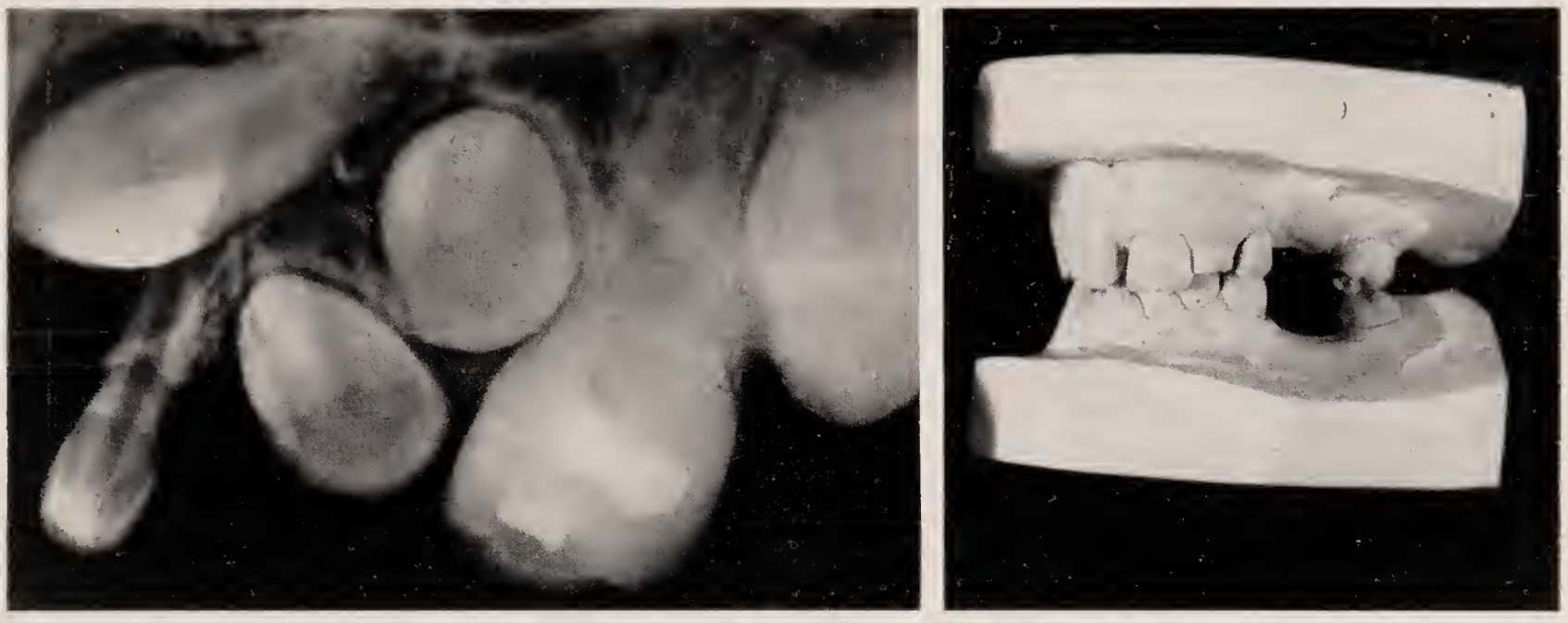


Fig. 10.—$\underline{|^{B}}$ is retained and $\underline{|^{2}}$ has erupted distally to it. The radiograph shows $\underline{|^{3}}$ erupting mesial to $\underline{|^{2}}$.

Fig. 11.—$\underline{^{2}|}$ has erupted distally to retained $\underline{^{B}|}$ and $\underline{^{3}|}$ is erupting mesially to $\underline{^{2}|}$ above $\underline{^{B}|}$.

forwards and none backwards". He goes on to say ". . . and I have not been able to find any evidence that teeth move backwards except when driven by an outside force, e.g., an erupting canine might drive a first premolar distally where there was room for the tooth to move". Though I would agree that the normal

tendency is for teeth to move forwards, perhaps they can move distally from an inside force. That force could be the force of eruption with its direction modified by an atypical guide plane.

Now I want to draw your attention to the association between retained second deciduous incisors and transposition of canines and laterals. From time to time one comes across cases of permanent laterals erupting distal to their retained predecessors. Such a case is shown in *Fig.* 10. The permanent second incisor is now in the position of the previously lost deciduous canine. By virtue of the relatively long distance which it has to travel from its point of development, the permanent canine has considerable opportunity to be deflected off its usual path. If it should be a little more mesially inclined than usual, it

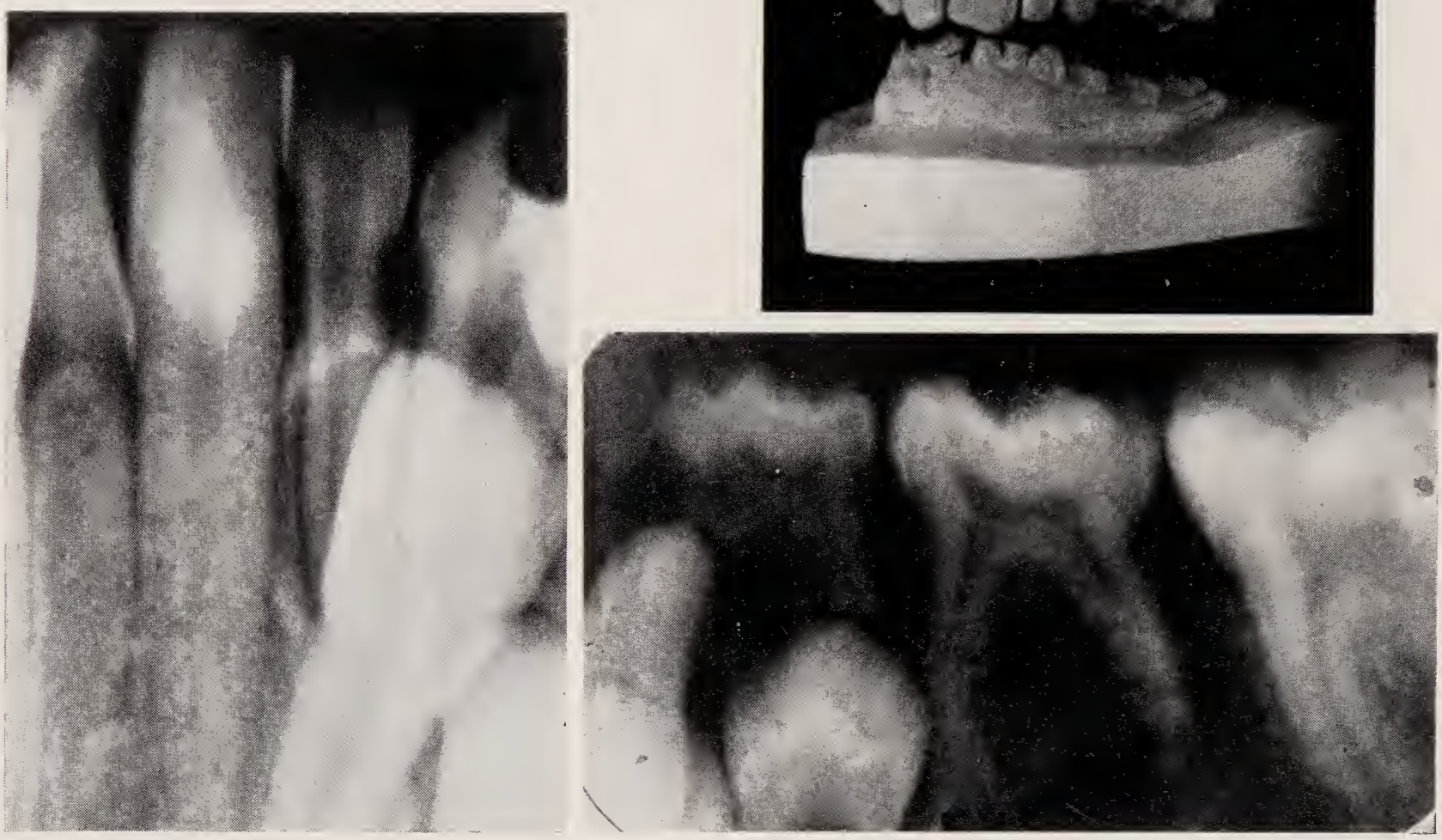


Fig. 12.—$|\overline{B}$ is retained and $|\overline{2}$ is leaning so far distally that the mesial root of $|\overline{D}$ is being resorbed by its pressure.

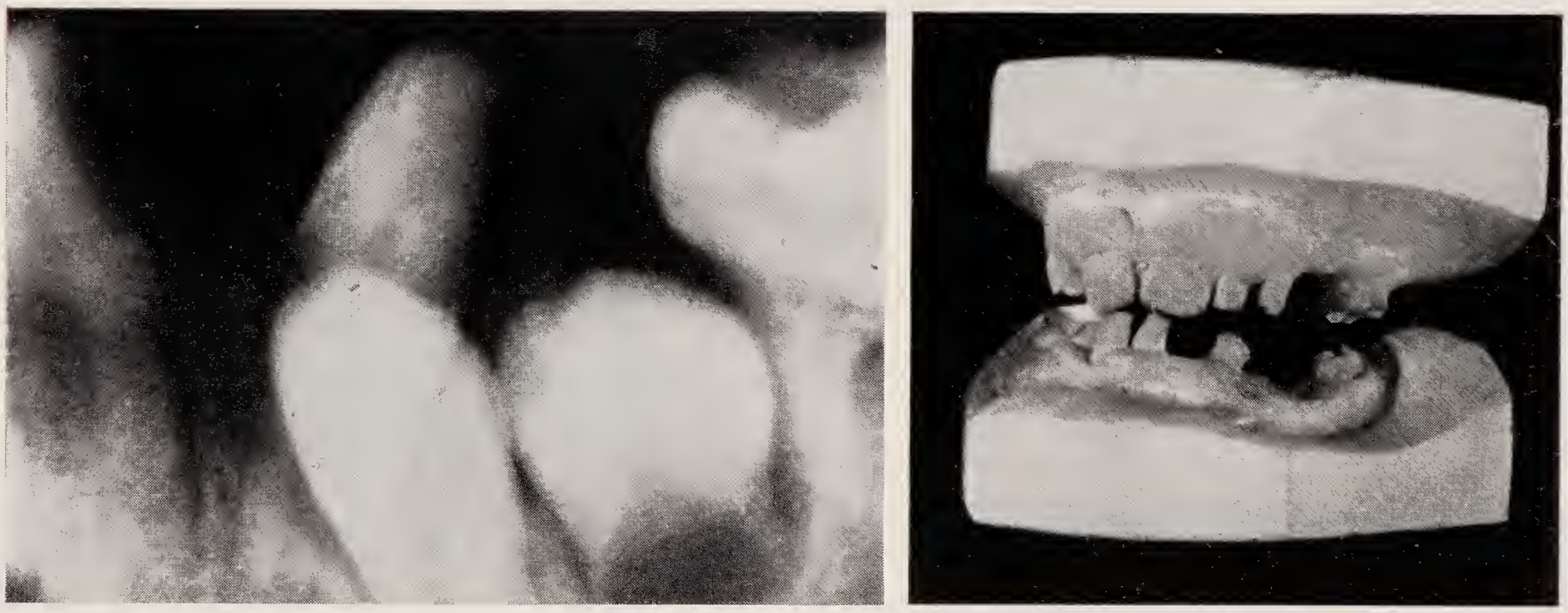


Fig. 13.—The same case as *Fig.* 12 ten months after extraction of $|\overline{BCD}$. Note that $|\overline{3}$ is erupting towards the space between $|\overline{12}$.

may well travel forward above the deciduous canine. Normally it would then come into contact with the lateral incisor root, and either be deflected back on to its more usual path or cause tilting of the lateral. However, if this occurs in a case like *Fig.* 10, where the deciduous lateral root has been resorbed, the canine will find a space to erupt into, and may come into the arch between the central and lateral incisor. The radiograph shows this potentiality occurring. A similar situation in another case is shown in *Fig.* 11. In *Fig.* 12, $\overline{|B}$ is retained, and in the radiograph $\overline{|2}$ is shown to be tilting distally, causing resorption of the mesial root of $\overline{|D}$. $\overline{|BCD}$ were extracted, and ten months later the situation was as shown in *Fig.* 13. From the position of $\overline{|2}$ and the inclination of $\overline{|3}$, this case has all the makings of the transposition of $\overline{|23}$.

An analogous situation is shown when a permanent lateral incisor is missing and the deciduous canine retains its proper position. Once again, if the permanent canine develops more mesially than normal, then it will be free to erupt into the empty space where the lateral should have been. The dentition will then read $\overline{4C31|}$, as shown in *Fig.* 14. This condition is seen in the upper arch as well.

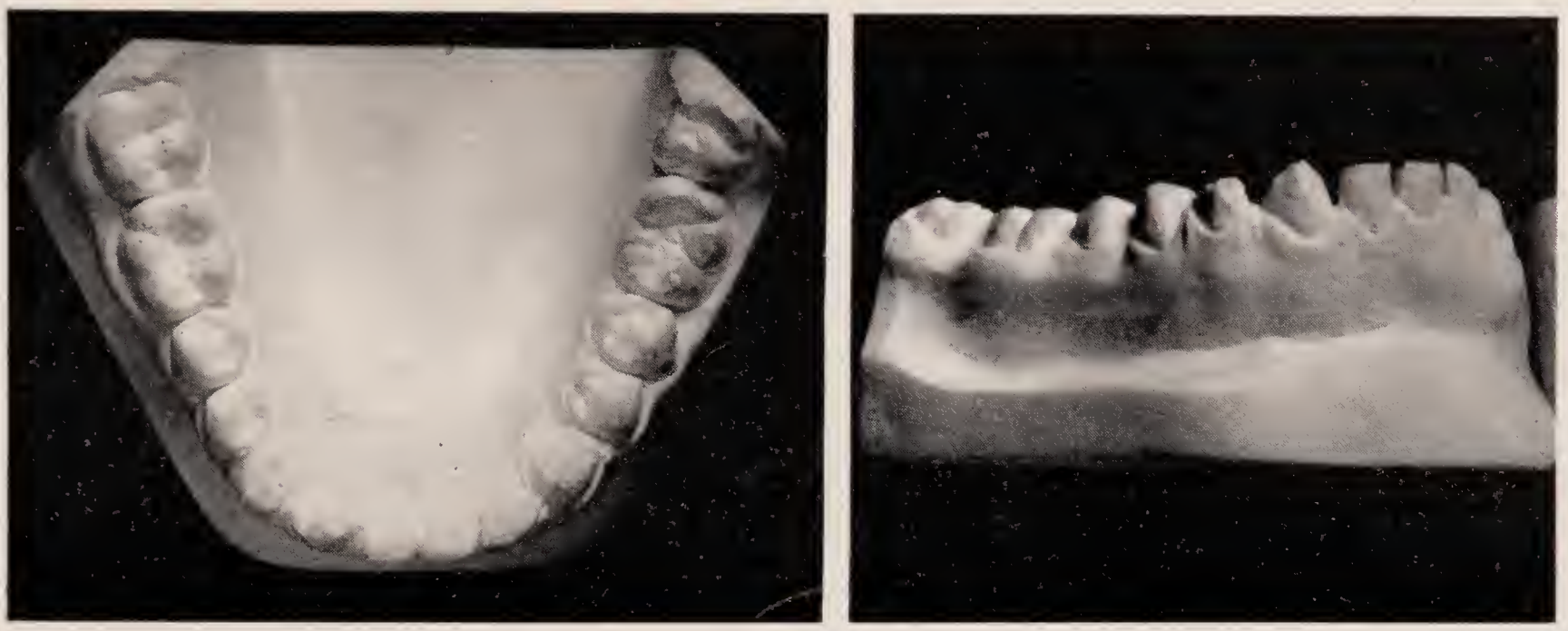


Fig. 14.—$\overline{2}|$ is congenitally missing. $\overline{3}|$ has erupted between the retained $\overline{C}|$ and $\overline{1}|$.

SUMMARY

1. An erupting premolar is guided to the surface by the roots of its deciduous predecessor and the contiguous teeth. If its environment changes then it will erupt on a different path. Some explanations of the change in environment are suggested.

2. The association between transposed canines and retained deciduous lateral incisors is pointed out.

Acknowledgements.—I should like to express my thanks to Mr. Schofield, of the Middlesex Hospital, and to Mr. Wilson, of the London Hospital, for permission to publish their cases; my thanks are also due to the Photographic Department of the London Hospital for preparation of the illustrations.

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DISCUSSION

The Chairman thanked Mr. Rose for his paper.

On the question of the retained deciduous central or lateral and the displaced permanent lateral, he asked if it might not equally be due to the position of the crypt of the permanent tooth. He was not saying that retained deciduous teeth never upset the permanent teeth, but he thought that particular case was frequently due to the developmental position of the lateral. The Chairman said that he sometimes took advantage of the tendency of teeth to erupt along the line of least resistance by

having the first premolars extracted early while the canines were still high up. The canines then tended to drop back into the space which had been created for them.

He had not been quite clear about the trimming of monoblocs. He could not see that the tiny facets would persuade the premolars to go backwards and joined issue with Mr. Rose on that point. If these facets were to have any effect, surely it would be to rotate the teeth rather than to move them backwards.

The Chairman then opened the subject for discussion.

Mr. H. G. Watkin said that he had noticed in one of the slides that the 6 had been extracted and the 5 moved distally. He thought there was no evidence of crowding at all and therefore the extraction of the 6 should not have been performed. It was most important in extraction of 6's to have definite evidence of crowding, otherwise one could get a space between two premolars.

Mr. P. H. Burke said he would like to ask whether Mr. Rose had noticed any association between transposition of maxillary canines and diminutive lateral incisors. Such transpositions might be expected, since the diminutive and retarded root of such a lateral incisor would not provide normal guidance for the eruption of the maxillary canine.

Mr. A. J. Walpole Day wanted to ask in general about the eruption of the lower premolars. He had observed many cases in which the lower 5, for example, was sloping backwards, and that appeared to be the normal pattern.

As the development of the occlusion proceeded there was a forward migration of the erupted teeth so that the roots of the E gradually uprighted the premolar underneath and subsequent radiographs showed the unerupted premolar in an upright position.

He would have liked to have seen a few slides showing the normal path of eruption of the premolar for comparison with the abnormal.

Mr. J. D. McEwen asked what relationship Mr. Rose put between the local factors and the genetic factors. He had recently had a case in Edinburgh with C3 standing and the missing 4, and when he had looked in the mother's mouth he found she had exactly the same relationship.

He also asked how much relationship there was in the cases Mr. Rose had shown. He had gained the impression from one slide that there was a missing upper lateral and in another case a missing lower 5.

Mr. F. K. Johnson asked Mr. Rose if there was any correlation between the vitality of the pulps of deciduous teeth and root resorption. He had noticed on one or two of the radiographs extensive cavities involving the pulps of those deciduous molars exhibiting imperfect root resorption; perhaps pulp infection could interfere with the normal process of resorption and thereby cause the developing tooth to be deflected.

He asked what was the objection to having spaces between premolars; he thought it could sometimes be of therapeutic and prophylactic value. Did Mr. Rose think contact points were absolutely necessary? Mr. Johnson said he knew it was not particularly relevant to the paper. but he was asking in reference to Mr. Watkin's point.

Mr. D. T. Hartley asked Mr. Rose to explain, with regard to the action of the Andresen appliance, if the guided movement of posterior teeth to which he had referred was primarily in a buccal, or in a distal, direction. He thought ambiguity on that point was the cause of some of the misunderstanding, but probably his own views were in accord with those expressed by the President.

Mr. J. S. Rose said in reply that he had been worried as to whether the radiographs could be seen, but he now realized that they could be seen only too well.

On the Chairman's point, whether the retained A or B would cause deflection directly over the erupting tooth or whether there was not an ectopic position to start with, he thought it was awfully difficult to say, except that the common point of malocclusion of the 1 or 2 was lingual and their position of development was lingual to the deciduous tooth. It would, therefore, be reasonable to say that that tooth was continued down its lingual path and the A or B which had been retained would not allow the permanent incisor to come into proper position.

With regard to trimming the facets on the monobloc, Mr. Rose said he thought it was much a matter of opinion. One could guide teeth and sometimes one did more than guide teeth, one actually put pressure on a particular point and encouraged a tooth to move in that direction. With a guide-plane one was pushing something away from one point and pushing it towards another point.

Mr. Watkins had mentioned extractions of 6's when there was no crowding. He did not want to attempt to justify the extraction of the 6's ; they were what was found when the cases were first seen and the extractions were due to caries or some other factor. He did agree that there was no orthodontic indication for extraction of 6's unless there was some form of crowding.

Replying to Mr. Burke, he had not seen enough of the cases of the incisors which had been mentioned to give an answer, but he had gained the impression that some were normal laterals and some were diminutive laterals. He agreed with preventive action, but if a C was not resorbing he would be happy to have it extracted.

Mr. Rose thought there was very commonly a distal inclination to the lower 5, but he did not know that it was normal. Perhaps one had not seen them early enough. They often came slightly out of the ordinary position and the environment of the deciduous roots would guide them into position rather like the first slide where the upper premolar came down between the guide planes of the adjacent teeth. So long as everything else was normal he thought it would be self-correcting, but once one altered the balance then the trouble would start.

On the relationship between hereditary and local factors Mr. Rose thought there was a hereditary association between transposition of teeth, and other cases of that had been reported, but whether there was a hereditary local factor, hereditary position of canine teeth which it might be possible to intercept by a change in environment or whether one just had transposition of tooth germs, which was possible, he did not know.

With regard to vitality of teeth and resorption, he thought non-vital teeth also resorbed and did not appear to be very much slower than others.

DETERMINATION OF THE ANGLE OF ROTATION OF THE UPPER FIRST PERMANENT MOLAR TO THE MEDIAN RAPHE OF THE PALATE IN DIFFERENT TYPES OF MALOCCLUSION

By **SHELDON FRIEL**, F.D.S. R.C.S.
Professor of Orthodontics, University of Dublin

It has been my experience that a large number of children of between 8 and 9 years of age retain the occlusion which would have been correct at 3 years of age. No forward positioning of the lower deciduous arch in relation to the upper arch has taken place. In the majority of these cases the upper arch has not widened sufficiently to release the lock of the deciduous canines and molars so that the lower arch can move forward; in addition, the upper first permanent molars are rotated mediolingually. These cases can be corrected very easily at the period of the mixed dentition by expansion of the upper arch and rotation of the first permanent molars, the lower arch usually moving into good occlusion of its own accord. Unless the upper and lower first permanent molars lock in their correct anatomical occlusion there will be more probability of a relapse after treatment.

Table I.—Rotation of Upper First Molars in Relation to Median Raphe of Palate

	Normal Cases		Post-normal Cases		Extraction Cases	
	Right	Left	Right	Left	Right	Left
Number	34	34	30	30	30	30
Mean in degrees	59·78	56·71	52·12	51·30	45·55	47·03
Standard deviation	5·32	6·44	6·01	7·21	8·31	9·91
Error of standard deviation	0·91	1·10	1·10	1·32	1·52	1·81

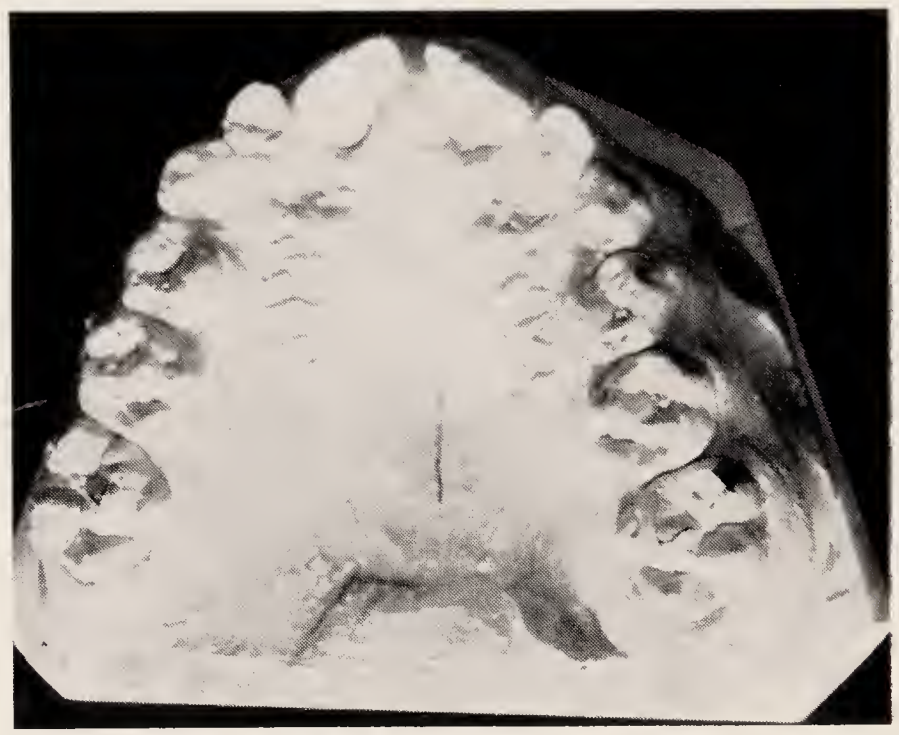


Fig. 1.—Showing marking of palatal raphe.

Table II.—Comparison of Sides

Significance of Difference between the Means of Normal Right Side and Normal Left Side

Actual difference: right 59·78°—left 56·71° = 3·07°.
Standard deviation 2·15.
The difference is significant.

Significance of Difference between the Means of Right Side Normals and Right Side Post-normals

Actual difference: normals 59·78°—post-normals 52·12° = 7·66°.
Standard deviation 5·43.
The difference is significant.

Significance of Difference between Means of Left Side Normals and Left Side Post-normals

Actual difference: normals 56·71°—post-normals 51·30° = 5·41°.
Standard deviation 5·43.
The difference is significant.

Table III.—Comparison of Sides

Significance of Difference of Means Post-normals and Extraction Cases

Post-normal Cases Right and Left Sides together

Mean 51·71°.
Standard deviation 0·86.

Extraction Cases Right and Left Sides together

Mean 46·29°.
Standard deviation 1·18.

Given at the Jubilee Meeting held on May 10, 1958.

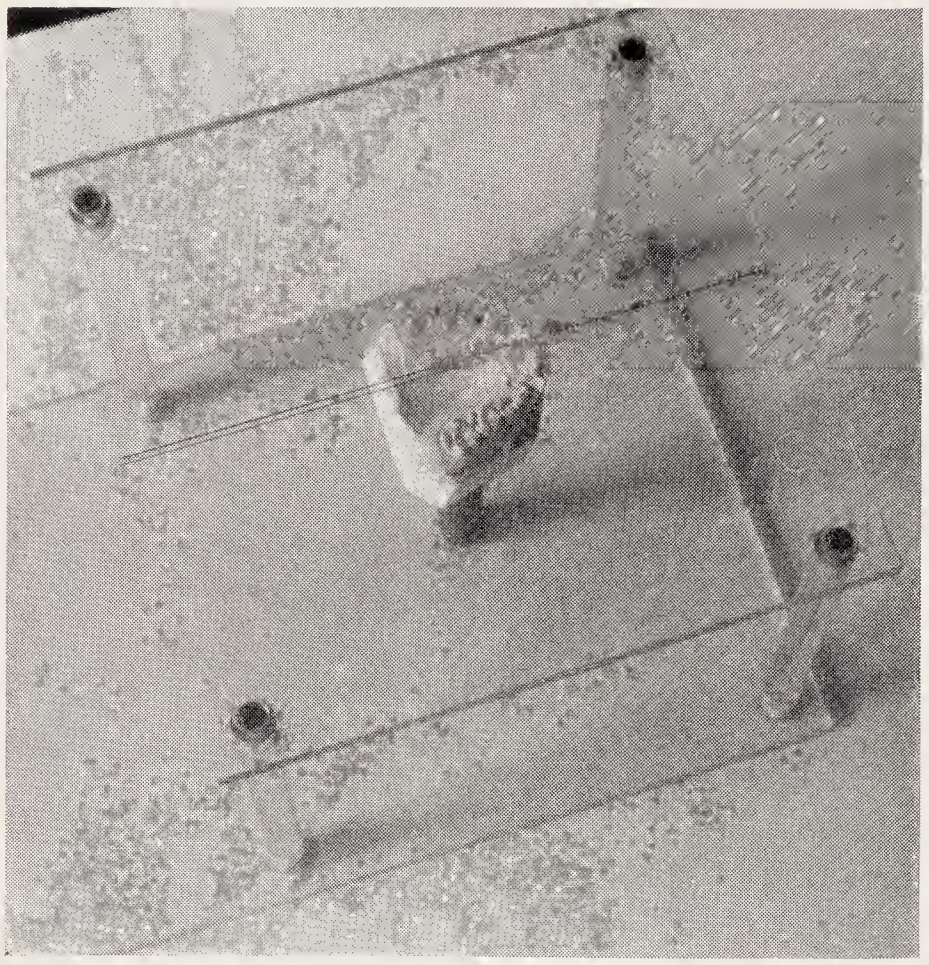


Fig. 2.—The apparatus.

A rotated upper first permanent molar can be observed with experience, but observation alone will not determine the degree of the rotation.

of the mediobuccal and mediolingual cusps and the median raphe. The raphe is marked far back where the vault of the palate is nearly flat (*Fig.* 1). It seems to me that this posterior end of the raphe was less likely to be influenced by environment than the anterior.

The apparatus to measure the angle of a line joining the two cusp points with the raphe consists of a sheet of perspex $\frac{1}{4}$ in. thick. A line is drawn anteroposteriorly on both sides of the sheet, each exactly opposite the other (*Fig.* 2). The sheet is supported on four pillars—the model is placed underneath the sheet and held in contact with it by a spring-loaded pointer. The model is now adjusted (*Fig.* 3) so that the three lines appear as one line. A tightly stretched fine wire is placed on top of the perspex sheet and in line with the points of the marked cusps. A protractor gives the angle of rotation.

The investigation consisted of 34 cases of normal occlusion in the premolar–molar area. These cases were mainly first year medical students. The second group consisted of 30 cases of post-normal occlusion with

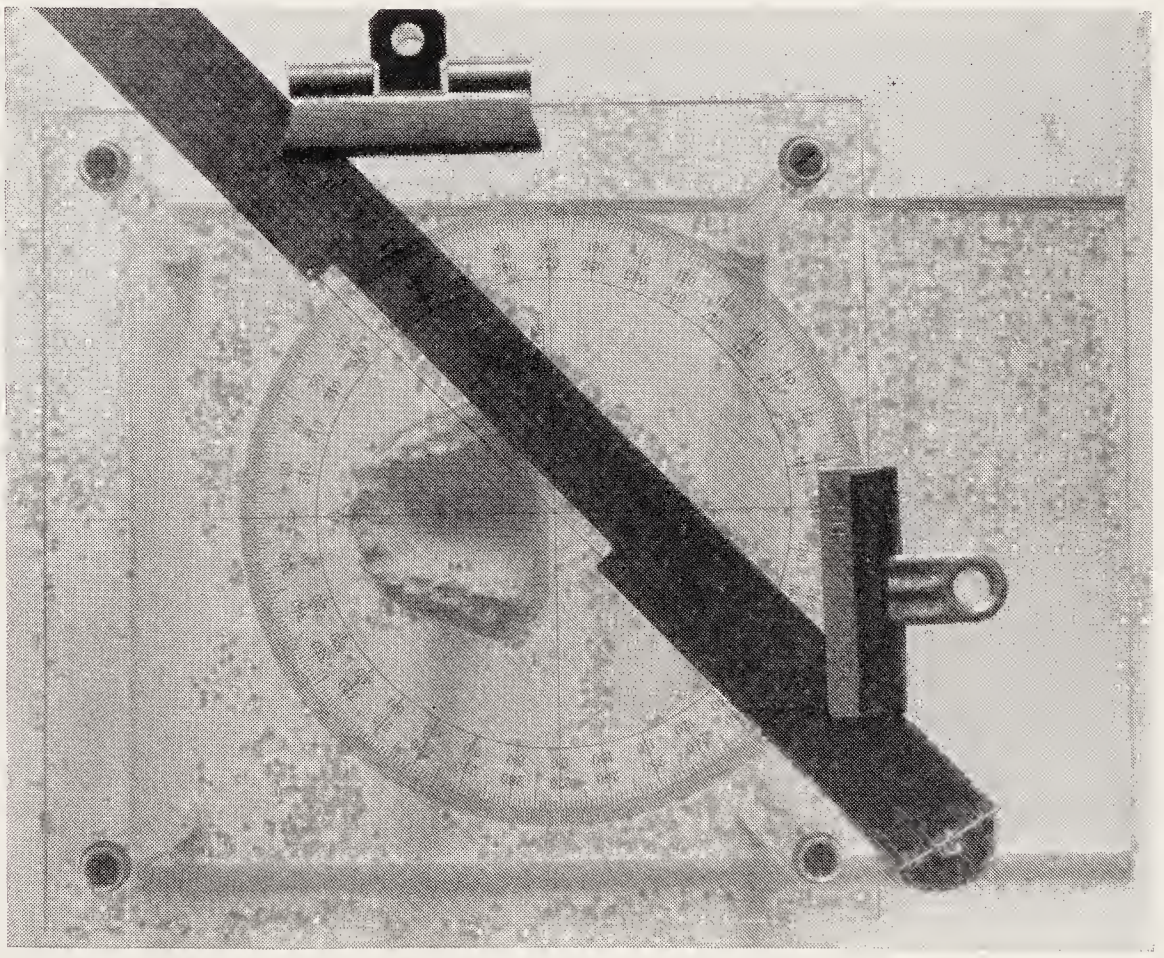


Fig. 3.—Method of measurement.

In order to discover the degree of rotation in different types of malocclusion, I have used the angle formed by a line joining the points labioclination of upper incisors and the third group of 30 cases where the upper second deciduous molar had been prematurely extracted.

The results of this investigation showed that in the first group (the normals) the mean angle on the right side was 60° and on the left side 57°. In the second group (post-normals) the mean angle on the right side was 52° and on the left side 51°, and in the extraction group the right was 45° and the left 47°. These figures are given in round numbers.

It was interesting to note that there was a significant difference between the right and left sides in the normals and in the post-normal cases, the left molar being more rotated. There was a significant difference between normals and post-normals on both sides. The extraction cases were far more rotated. (*Tables I–III.*)

Acknowledgements.—I am indebted to Mr. Thornton of Trinity College for working out the statistics and to Dr. Dockrell for the photographs of the machine.

DISCUSSION

The Chairman thanked Professor Friel for his interesting paper. The point which seems to be of importance is whether the actual angle of the two buccal sides to the median line was being measured or whether it was the rotation of the molar beyond that line. If it was the first then in a converging arch the angle must be smaller than in a squarer arch.

Professor Friel replied that it was the rotation of the molar beyond the line of the arch.

The topic was then opened for general discussion.

Mr. E. K. Breakspear thanked Professor Friel for his paper and said that he was interested in the difference between the left and right sides. He was not quite clear as to which was the more affected; could Professor Friel clarify this point?

Mr. J. R. E. Mills asked Professor Friel if he could give any reason for the rotation of the upper molars. In normal occlusion the mesiolingual cusp of the upper first molar occluded in a deep fossa in the centre of the lower first molar. This forms a very constant relationship throughout all mammals and constitutes a strong mechanical lock. It seemed to Mr. Mills that when the upper molar tended to drift mesially, it was easier for the buccal cusps to do so than it was for the mesiolingual cusp. Consequently, the tooth tended to rotate.

He wondered if Professor Friel knew where the mesiolingual cusp occluded in cases of post-normal occlusion.

Mr. A. G. Taylor said that one point about the paper that was intriguing was that in the normals the right differed from the left; that did seem to be rather extraordinary. He wondered whether Professor Friel considered the right side did differ from the left or whether it was the median raphe which might be diverted a little to one side, or whether it was actually plumb centre.

Mr. H. G. Watkin said that with an upper molar the palatal root, as they well knew, was much larger than the two buccal roots, and therefore if one removed an E, for example, the pressure from the back would push the molar forward and it would rotate round the palatal root. He asked whether Professor Friel would agree with that.

Mr. R. O. Hellier said he was wondering whether Professor Friel had any records to show if they were right- or left-handed people.

Mr. Russell said that in determining measurements, even to within one degree, there were so many variable factors in a study of the nature described which had not been mentioned or taken into consideration that he did not think the figures given were statistically relevant. A mere millimetre in an anterior plane would make quite a difference in the degree of rotation to right or left. The figures produced were interesting, but there were so many variable factors, as the Chairman had pointed out; for example, the arches might be convergent or parallel and one side could be at a different angle from the other. Another point to consider was the distance of the raphe from each individual tooth, and that had not been mentioned.

Professor Friel, replying to the point about the age group of the extraction cases, said he thought probably it ranged from 5 to 9 years of age; the earlier the extraction the greater the rotation and forward movement of the tooth. The greatest rotation he had seen was 30 degrees to the raphe, which meant the median buccal cusp point and the distal lingual cusp point were parallel to the median raphe, but there were not many of those.

Were they right-handed or left-handed? He had, as a matter of fact, noted whether the medical students were right- or left-handed, but he had not the figures with him; he had not taken notes of the others. He did not think there was any connexion.

No Class II, division 2 or Class III's had been taken.

The reason for rotation was that the palatine root acted as a rudder, and when the tooth moved forward it would hold the rudder out. Years before, Professor Friel had collected a lot of first permanent molars and just slid them down into glass tubes that would hold them comfortably. He filled the glass tube with a thick, clear, viscous fluid and dropped the molars, one after the other, all going the same way, all dropped head foremost, into the fluid; they all rotated in the same way. If one did the opposite thing and put the roots forward they would rotate the opposite way. Those were the only teeth that were uniform in that method of rotation.

In regard to the shape of the arch, if one had a V-shaped arch the molar would be rotated naturally. That was why the post-normals were rotated more than the normals.

In thanking Professor Friel for his paper, the *Chairman* said that most people would know that Professor Friel was an authority on occlusion and the development of occlusion. There was very little he did not know about that subject. He had been interested in the rotation of molars for very many years.

DISTAL MOVEMENT OF PREMOLARS AND CANINES

By J. ANGELMAN, L.D.S.

ORTHODONTIC cases present themselves where the first permanent molars cannot be saved, or have recently been removed, and there exists:—

1. Generalized overcrowding in labial and buccal segments.

2. Overcrowding in either labial or buccal segments.

The problem is to retract the premolars so as to make room for the correction of part or the whole of the labial segments.

The following is a description of appliances designed to retract the premolar teeth and where necessary, the canine teeth, and guide them into the arch. This has to be achieved before the second permanent molars erupt, the

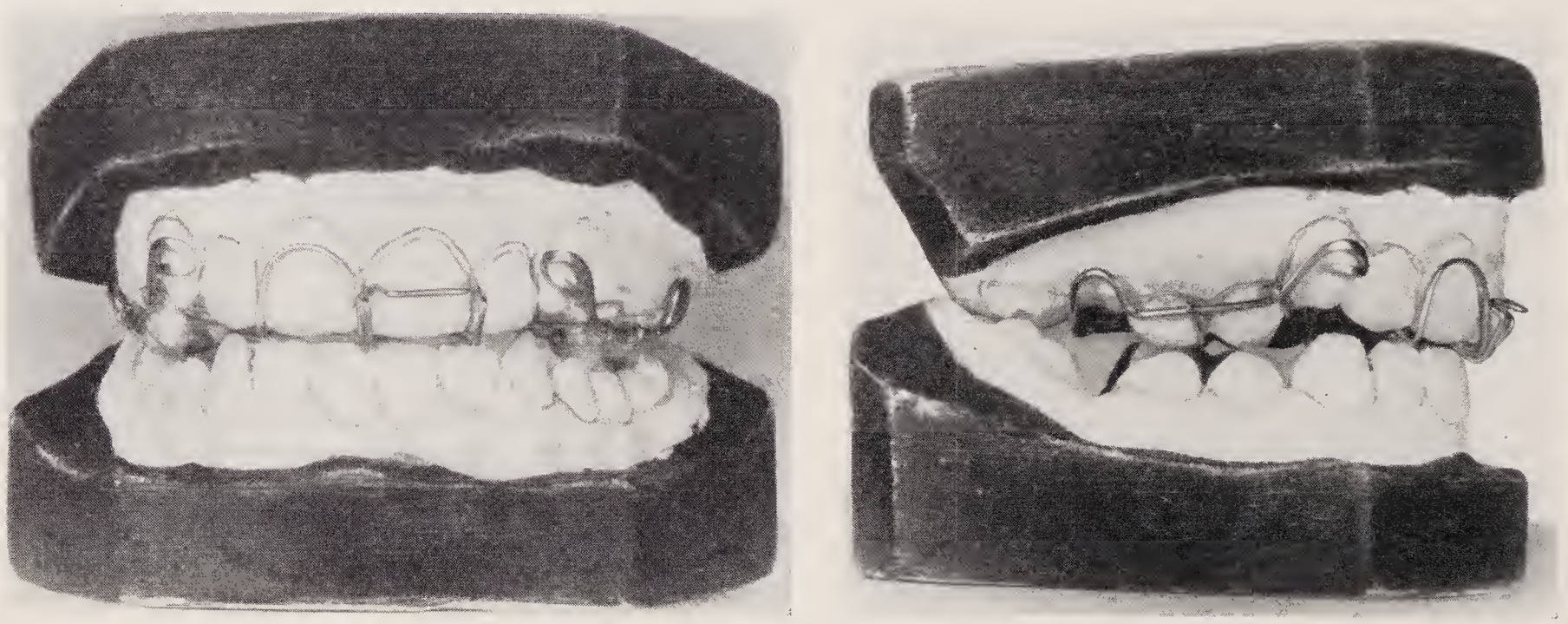


Fig. 1.—Demonstrates a frontal and lateral view of the appliance in situ, showing the mode of anchorage, the lateral arms acting as a guide and stabilizer to the premolar retraction springs, and as a canine retractor.

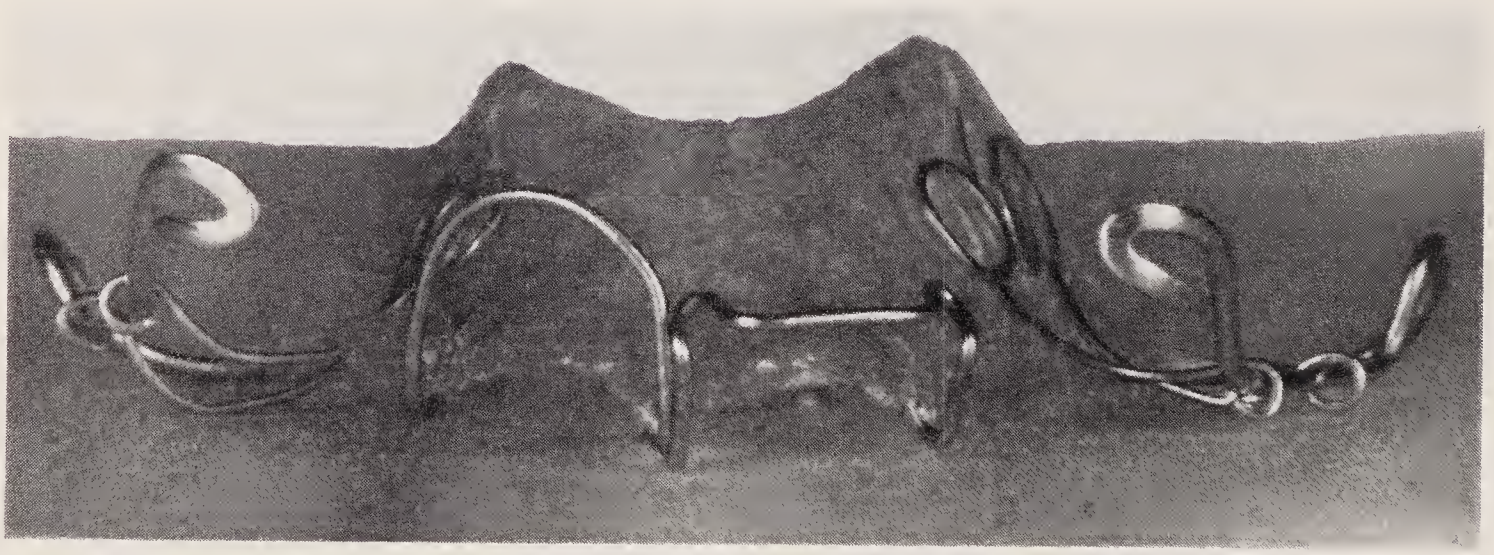


Fig. 2.—Shows a palatal view of the appliance with the coiled palatal springs.

3. Forward movement of buccal segments with insufficient room for the canines, which may be unerupted or in the process of eruption.

time factor being of importance, more especially in the maxillary arch where the second permanent molars rapidly occupy the position

A demonstration at the Jubilee Meeting held on May 10, 1958.

of the first permanent molars. If the distal movement of the premolars and eanines is not aehieved in time, overerowding is maintained, whieh may neeessitate the further loss of dental units.

Lateral Arms.—Two lateral arms constructed in 1·0 mm. wire extend from the distal aspect of the appliance, bueeally to the eanine area. The distal eurve of the arm where it leaves the aerylic plate lies anterior to the area where the

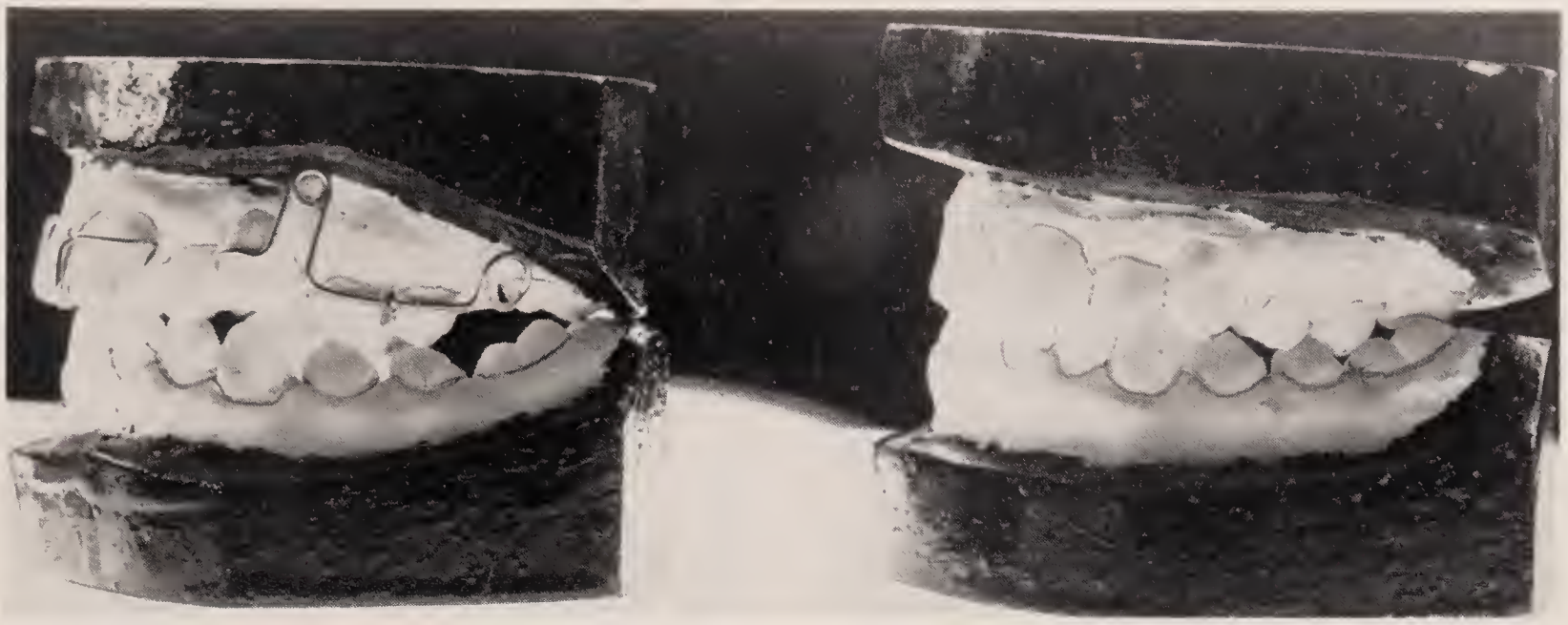


Fig. 3.—Shows a case being treated with the snatcher type modification of the lateral arms, the models on the right showing the final alinement of the bueeal and labial segments.

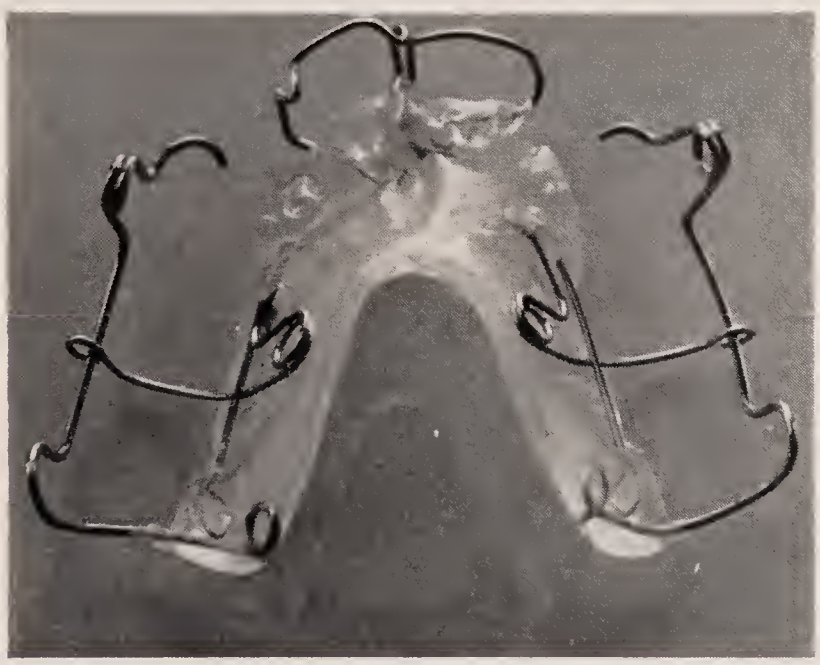


Fig. 4.—Shows a palatal view of the appliance used to detail the method of its construction.

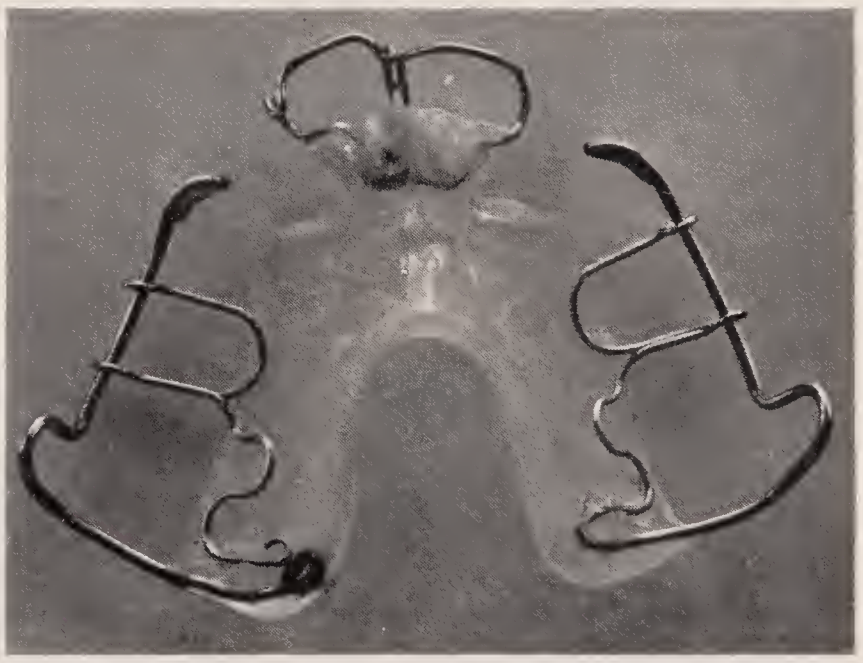


Fig. 5.—Palatal view of the appliance used to illustrate the design of the premolar retraction springs.

The applianees and eases deseribed below deal with the maxillary areh, but the principles apply equally well to the mandibular areh.

Anchorage.—This is obtained by elasping with Adams eribs or eontinuous eribs, or a combination of both:—

1. The eentral ineisors.
2. Central ineisor and lateral ineisor.
3. Two lateral ineisors.

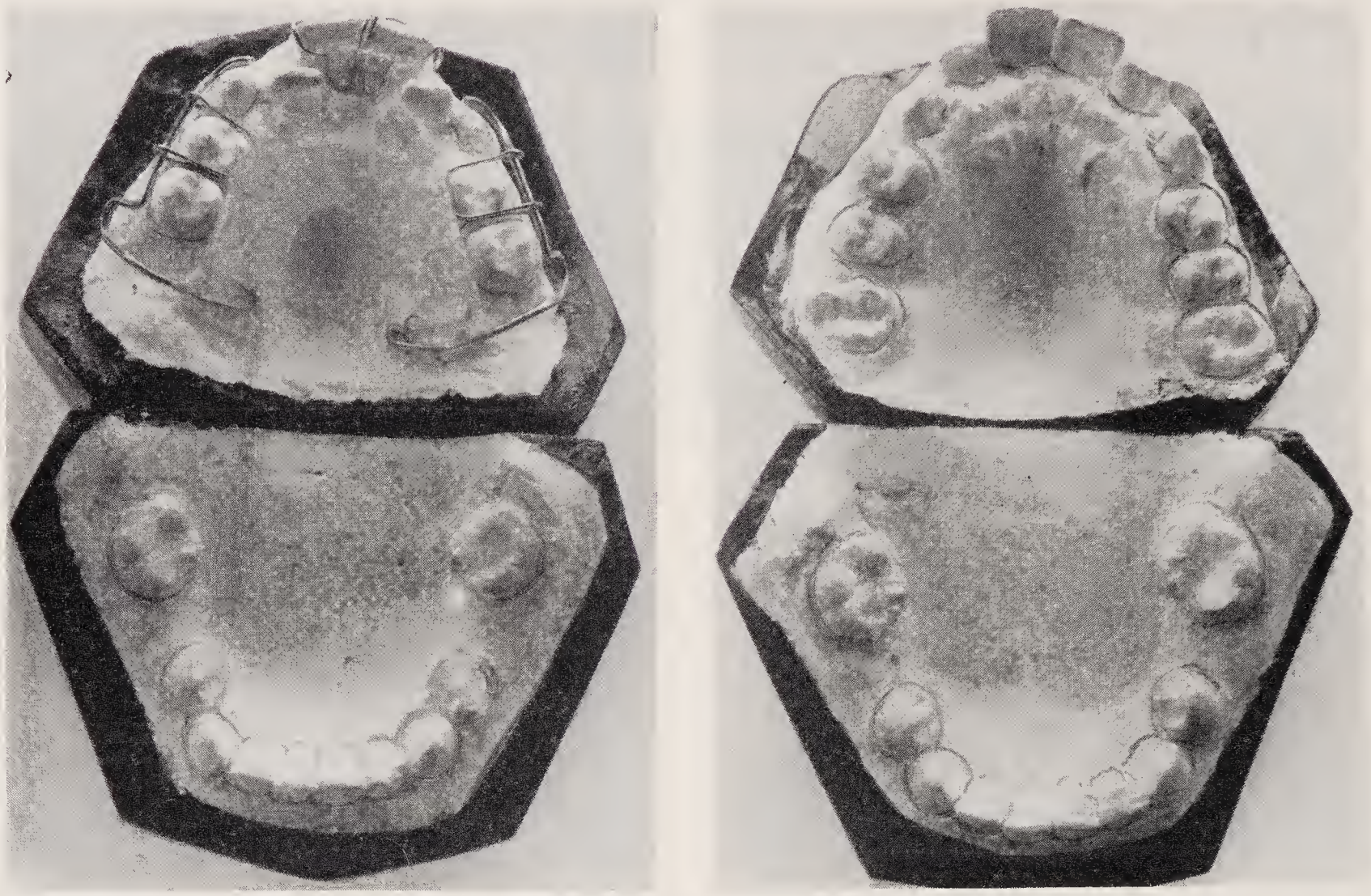
The anehorage thus obtained is quite rigid, and is amply illustrated in the figures below.

seeond molar will erupt. This can be assessed by inspeetion and where neeessary by radiographs. If the tooth is erupting the eurve will aet as a spaee-maintainer to prevent forward movement, until the premolars and eanines are retracted.

The bueeal extension of the arm has two funetions:—

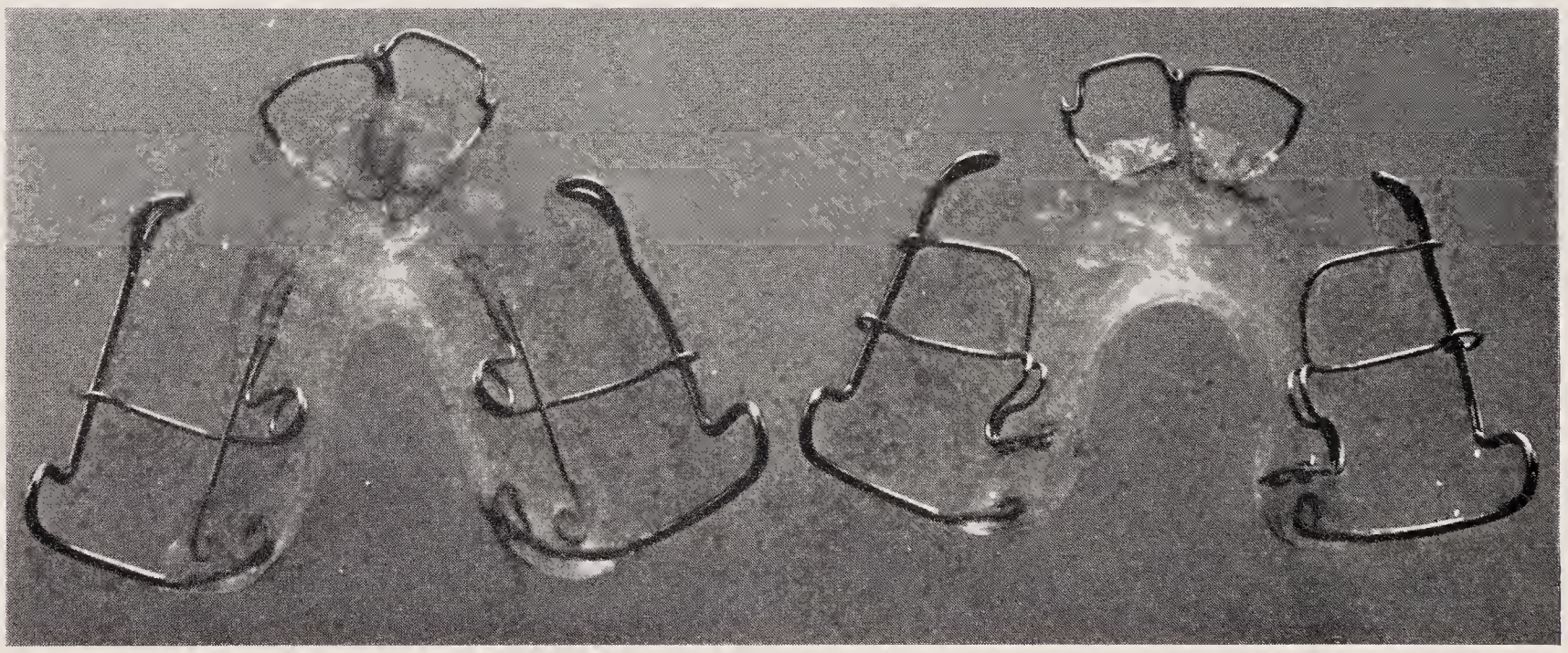
1. To aet as a guide and stabilizer for the premolar retraction springs.
2. To retraet the canine teeth when they are mesially inclined or erupting in labioversion.

To achieve this the free ends of the buccal arms are flattened and curved to embrace the mesial aspects of the crowns, and a U-loop (*Figs.* 3, 4) where it is constructed in 0·8 mm. wire, the free end designed as a snatcher type of canine retractor.



A B

Fig. 6.—Shows the case described in the text, (A) before, and (B) following treatment.



A B

Fig. 7.—Shows further modifications of the appliance showing the design of the premolar retraction springs and their method of attachment.

incorporated near the distal ends. Gentle closure of the loops will produce a distal pressure on the canine teeth (*Figs.* 1, 6). Modifications of the lateral arm can be employed

Premolar Retraction Springs.—Two 0·5 mm. wire extensions, coiled near their point of fixation into the palate, pass across the premolar teeth to exert pressure on their

mesial surfaces. Their free ends are coiled once round the lateral arms which act as a guide and stabilizer. In this way four premolars are moved simultaneously (*Figs.* 1, 2).

Several modifications of premolar retraction springs can be used. *Fig.* 4 shows a single retraction spring guided on the lateral arm and palatally by a wire extension. This can be employed to retract the premolars individually.

Figs. 5 and 6 show the design and construction of a double retraction spring from a single length of wire. The gradual closure of the palatal U-loop retracts the premolars simultaneously. In this case 2|2 were in linguoversion and excluded from the arch by the approximation of 31|13. *Fig.* 6 B shows the case following treatment in which 543|345 were moved distally by the appliance demonstrated in *Figs.* 5 and 6 A. 2|2 were subsequently re-alined into spaces made for them.

A further modification is illustrated in *Fig.* 7 B which shows two premolar retraction springs, the U-loops lying in apposition. The springs can be adjusted to move together, or at different pressures, or individually.

A METHOD OF TREATMENT IN ANGLE CLASS III MALOCCLUSIONS

By **C. P. BRIGGS**, B.D.S., D.D.O.

The treatment of the Angle Class III malocclusion by orthodontic methods poses some of the most difficult problems in this field of dental surgery. The severity of the case may vary from a very mild edge-to-edge incisor relation, often associated with a postural element (Hopper, 1955), to gross

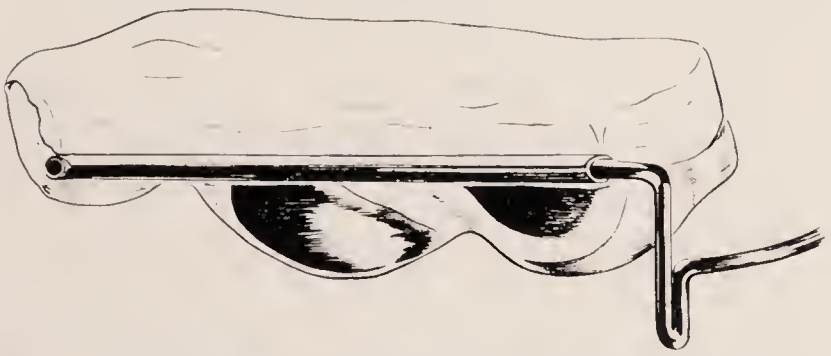


Fig. 1.—Showing silver-acrylic splints before fitting.

conditions where only plastic surgery can be of value. It has been said that, where the degree of protrusion of the lower incisors in front of the uppers is more than 5 mm., operative treatment is called for (Haüpl, Grossman, and Clarkson, 1952). Fortunately the patient with a true Class III malocclusion occurs least often, 3 per cent of all malocclusions being a figure quoted (White, Gardiner, and Leighton, 1954).

It has been recognized that irregularities of this nature may be grouped into definite morphological types (McCallin, 1956), and, although a wide range of variation does occur, it is for one of these that a new method of treatment has been devised and used successfully.

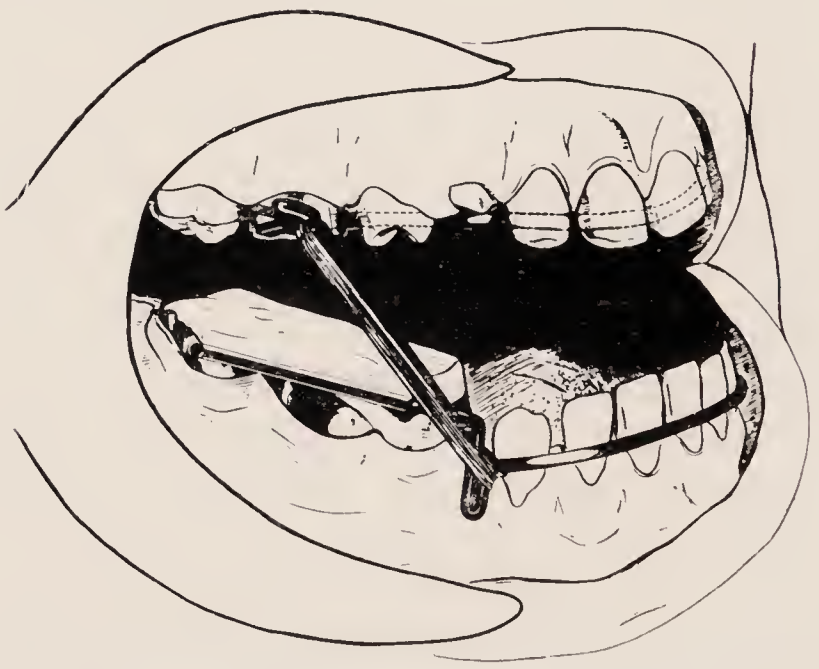


Fig. 2.—Showing completed appliance as worn in the mouth.

The method is applicable to those cases where there is a mild yet definite inferior basal prenormality in addition to the occlusal

A demonstration at the Jubilee Meeting held on May 10, 1958.

malrelation. The dental arches may or may not be mutilated by extractions. It is helpful, however, to deal with local irregularities, if severe, before applying this method of treatment.

Previously, treatment for these cases has usually been directed towards the advancement of the upper labial segment, either by means of fixed apparatus with fine wire

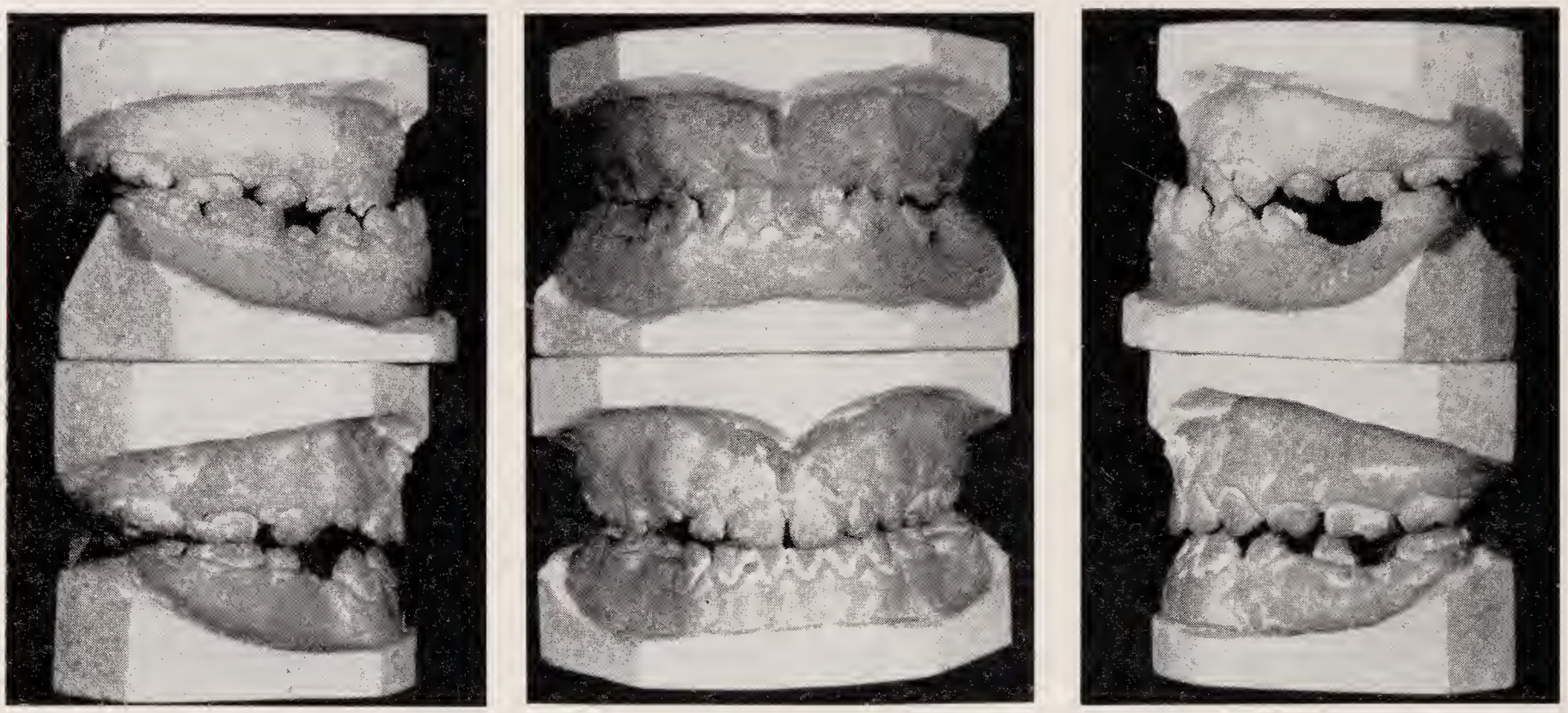


Fig. 3.—*Case* 1. Models showing results of treatment.

auxiliary springs, simple reversed intermaxillary traction, or with removable screw and spring plates. The lower dental arch may be treated either by extractions or by means of extra-oral traction (Chapman, 1950). Occipitomental anchorage such as that originally described for use with cleft lip and palate cases (Kettle and Burnapp, 1955) has also been used successfully.

The apparatus used in this method requires the construction of two cast silver splints which fit over all the erupted lower cheek teeth on each side and bear on their occlusal surfaces retention tags to retain acrylic. Providing there is no spacing between the lower teeth at the time of commencement of treatment, extraction of the lower first premolars is indicated. When the splints have been made, they are tried in the mouth. They should have wax blocks placed on their occlusal surfaces at this stage. These are reduced at the try-in until the posterior teeth are just sufficiently gagged to free the adverse incisor relation. There should be a short length of stainless steel tubing, 0·8 internal diameter, incorporated at the time of casting on to the buccal surfaces of each splint. To reduce the bulk of silver, the splints may be hollowed out occlusally.

After a try-in, the splints are returned to the laboratory and the wax blocks replaced by acrylic processed directly on to the retention tags (*Fig.* 1). A sliding facial bow is then adapted around the lower incisor teeth, hooks to receive intermaxillary elastics being incorporated in the region of each lower canine.

The upper first permanent molar teeth are banded and a hook soldered on to the buccal side of each band to receive the superior end of the intermaxillary elastics. The anchorage is stabilized by means of a palatal bow attached to each band (*Fig.* 2).

The action of this apparatus is two-fold:—

1. The silver-acrylic gags free the incisors and allow them to be correctly re-orientated with each other.

2. The intermaxillary elastics have a reciprocal action in retroclining the lower anterior teeth and stimulating a forward movement of the whole upper dental arch.

It has been found, on completion of treatment by this method, that, when the gags are

removed, some degree of posterior or lateral open bite may be present. Experience has shown, however, that when there is a gradual reduction in the height of the gags, followed by the removal of the entire splint, this open bite closes spontaneously.

CASE REPORTS

Case 1.—J. C., female, aged 15 years. This patient was seen to have a pre-normal occlusion, the lower incisors coming facially to the uppers on closing, without any posturing forward. Treatment by this method was considered to be suitable and $\overline{4|6}$ were extracted. The lower molar was removed rather than a premolar because of caries. When $\overline{|5}$ had been retracted sufficiently, it was observed that enough space had appeared between $\overline{|3}$ and $\overline{|4}$ to justify the commencement of treatment. In June, 1957, the apparatus was fitted and, by October, 1957, the incisor relationship was reversed (*Fig.* 3). The diagram (*Fig.* 2) shows the assembled apparatus during treatment.

Case 2.—D. M.-M., male, aged 9 years (Mr. J. H. Gardiner's patient).

In September, 1954, this case was examined and found to have a pre-normal occlusion such as that described above. There was an intact lower arch with spacing in the lower incisor region. The upper arch was well developed, although $\underline{E|ED}$ were missing. When the teeth were brought into occlusion the upper incisors bit well inside the lower arch.

In view of the spacing in the lower arch, no lower units were removed. Apparatus was fitted in September, 1954, and three months later the upper central incisors could be seen to be over the bite. Models taken in December, 1956 (*Fig.* 4), showed that this relationship had been retained. It was necessary, however, to fit a fixed palatal bow with fine wire springs to guide the erupting upper lateral incisors into correct position at a later date.

SUMMARY

A method is described for treating a certain type of Class III malocclusion, using fixed apparatus with silver-acrylic overlays. Two cases are described showing successful results obtained with this apparatus.

Acknowledgements.—My thanks are due to Professor G. L. Roberts of the University of Sheffield for permission to describe the two treated cases; to Mr. J. H. Gardiner for the initial work on this apparatus; to Mr. R. Cousins for the photographs; and to Mr. E. D. McBride of the Royal Dental Hospital for technical assistance in preparing the models used at the demonstration

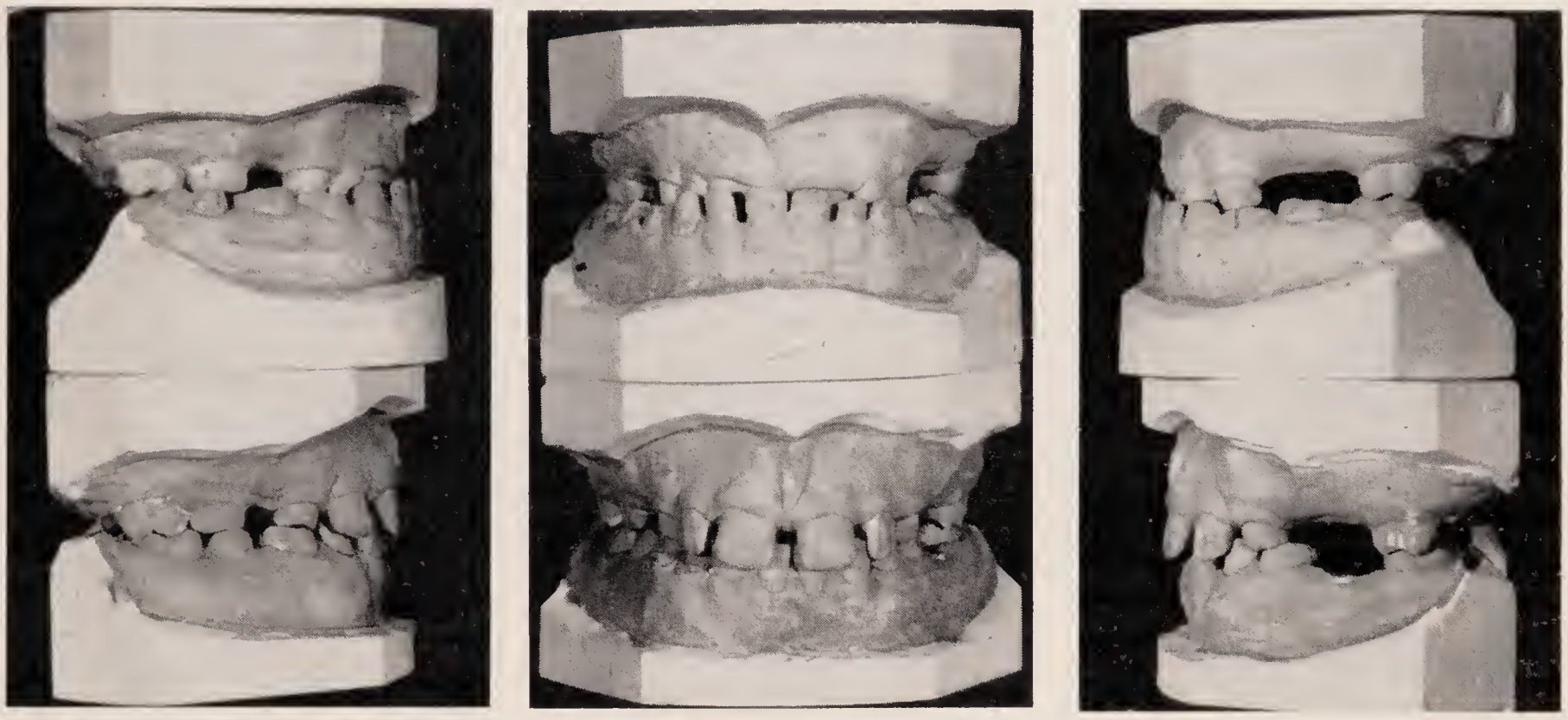


Fig. 4.—*Case* 2. Models showing results of treatment.

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THE RUBBER PEG PLATE

By **G. B. HOPKIN**, H.D.D., D.D.O., L.D.S.
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WITH the disappearance of hickory wood during the last world war the peg plate appears to have fallen into disuse. A modified form of peg plate has been used by the Orthodontic Department of the Edinburgh Dental Hospital since its introduction by Mr. J. D. Hamilton Jamieson.

The appliance is used mainly for the labial movement of lingually occluding upper incisors. It consists of an upper plate built up behind the incisors to form a flat biting plane (*Fig.* 1 A) level with the incisal edges of these teeth. The plate is extended over the occlusal surface of the cheek teeth, the so-called molar capping (*Fig.* 1 B), and retention is provided by the modified arrowhead (Adams) clasp usually on the upper first permanent molars. Technical points to note are the use of a stone model to reduce the risk of misfits due to crumbling of the cusps of the cheek teeth, and the plastering out of the mesial arms of the clasps where they pass over the occlusal aspect of the interproximal space to prevent the arms becoming embedded in the molar capping and so making the clasps too rigid. The distal arms of the clasp are left free of the molar capping.

FITTING THE APPLIANCE

The occlusal surface of the molar capping and the anterior biting plane are ground to the occlusion of the mandibular teeth and the bite closed until the lingually placed upper teeth just clear the lower incisors. If the bite is closed too far and the lower incisors overlap the upper, the bite must be opened again by the addition of quick-setting acrylic.

ACTIVATING THE APPLIANCE

With a No. 7 round bur drill a tunnel tapering from the fitting to the palatal surface of the plate opposite the tooth to be moved (*Fig.* 1 C). Countersink the orifice of the tunnel to accommodate the compressed rubber peg.

Take a length of Ash No. 4 separating rubber strip, trim one end to a point, tie a length of floss silk to the tapered end and pass the floss silk through the tunnel pulling the rubber strip through from the fitting to the palatal surface (*Fig.* 1 D), leaving about 1 mm.

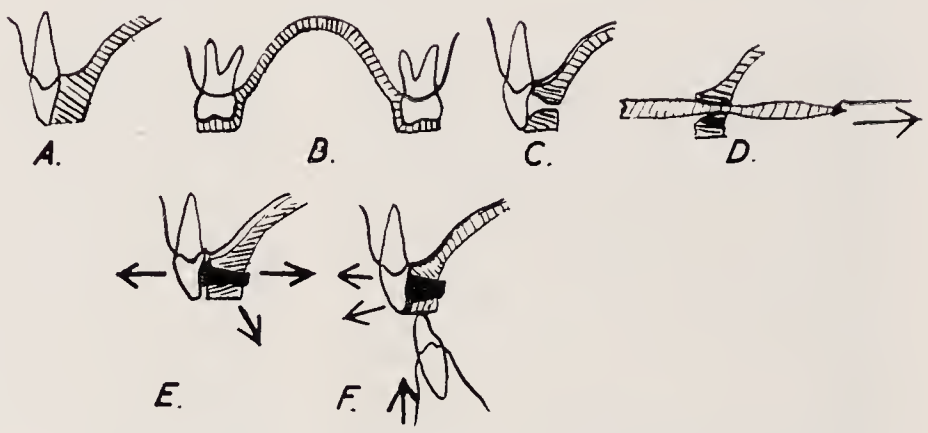

Fig. 1.—A, Anterior bite plane; B, Molar capping; C, Tunnel for rubber peg; D, Method of inserting rubber peg; E, Slight displacement of plate due to "back thrust" of peg; F, Countering of back thrust and increase of forward force due to biting of lower incisors on the bite plane (for fuller details *see* text).

projecting from the fitting surface. Holding the excess rubber strip under tension, cut it off flush with the palatal surface, thus avoiding a projection of the strip; if a flush cut is not achieved the projecting end can be trimmed flush with a carborundum stone. The diameter of the tunnel is made less than the width of the rubber strip, which is pulled through under tension and therefore elongated and narrowed. The compressed part of the strip in the tunnel exerts a lateral pressure and the peg is thus held in place.

When the appliance is inserted the force generated by the compression of the projecting rubber peg between the plate and the tooth is exerted partly in a forward direction against the tooth and partly backwards, causing a slight downward and backward displacement of the anterior end of the plate (*Fig.* 1 E).

When the teeth are occluded in eating and swallowing this backthrust is countered by the occlusal force of the lower incisors on the

Based on a demonstration given at the Jubilee Meeting held on May 10, 1958.

biting plane, thus momentarily increasing the forward force on the tooth (*Fig.* 1 F). This biting of the plate up and the following relaxation induces a "bounciness" into the plate which the children do not appear to mind; they are of course warned about the sensation. If a child appears uncertain when the appliance is fitted, he is allowed to wear the appliance for a week to gain confidence before the peg is inserted.

The peg is changed at intervals of 2–3 weeks, a slightly longer peg being inserted at each visit. The average duration of treatment to move an incisor over the bite is 6–8 weeks. The rubber peg may be used to open up space between adjacent teeth, a double-ended peg being used (*Fig.* 2). Rubber pegs can be used in an Andresen or Monobloc to assist the labial movement of the lower incisors or the buccal movement of cheek teeth.

While it is not claimed that the appliance is superior to other methods of achieving the same ends, it has the merit of simplicity of construction and the peg is not susceptible to distortion or breakage.

Two cases illustrating the use of the appliance are shown in *Fig.* 2. *Fig.* 2 A shows the use of the double rubber peg to open up space for a surgically exposed $\underline{1}|$ following removal of the midline supernumerary. *Fig.* 2 B shows the treatment of lingually occluding $\underline{1|1}$ in two stages. First the labial movement of $|\underline{1}$ (lower appliance) followed by the labial movement and rotation of $\underline{1}|$ (upper appliance on model). The rubber peg was directed against the distopalatal surface of $\underline{1}|$ and a labial arm was adapted to bear on the mesiolabial surface to effect the rotation.

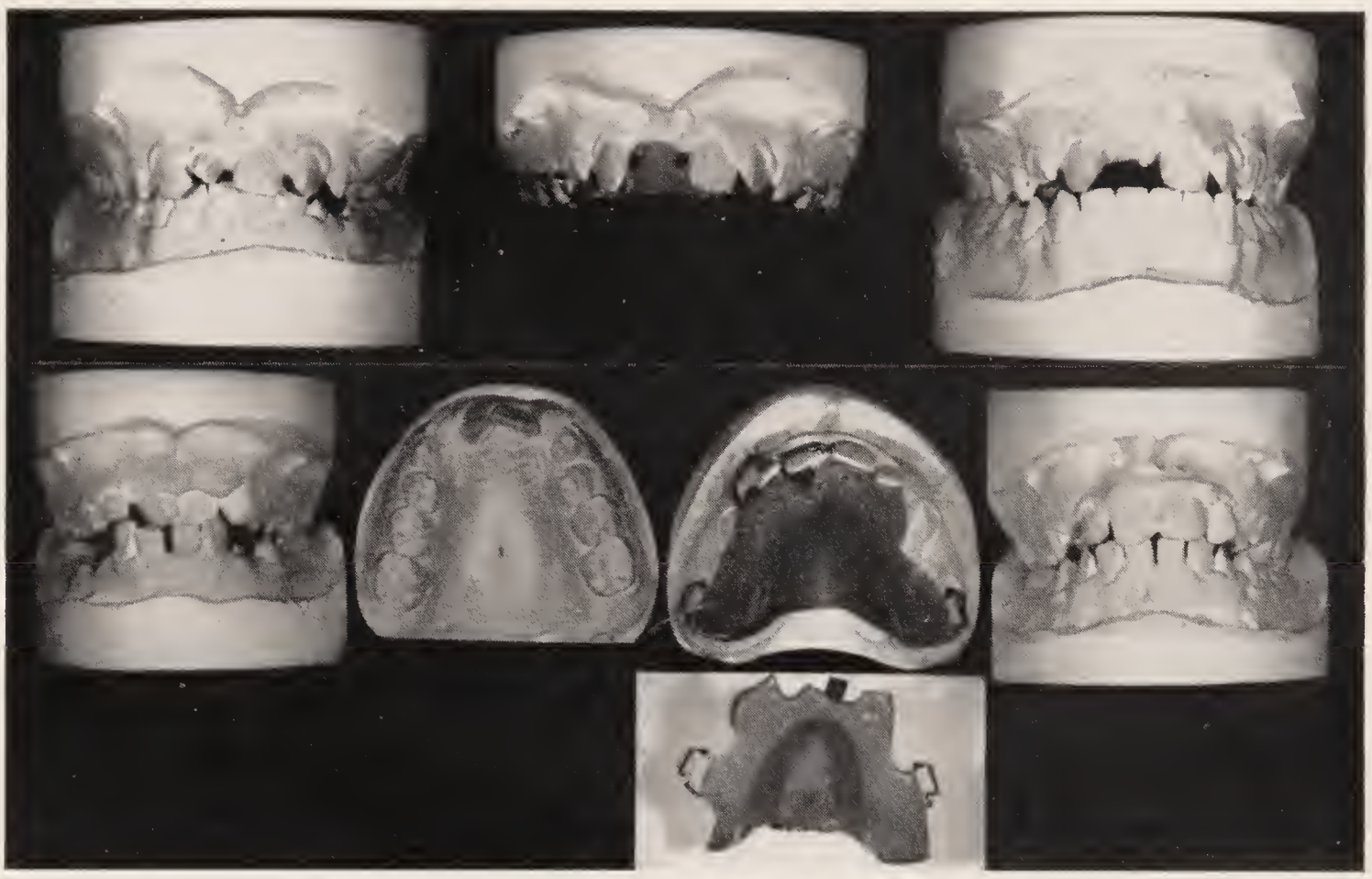

Fig. 2.—A, Double rubber peg used to open up space for unerupted $\underline{1}|$ after extraction of midline supernumerary; B, Rubber pegs used to correct lingually occluding $\underline{1|1}$ in two stages:—1, Labial movement of $|\underline{1}$ (lower appliance); 2, Labial movement and rotation of $\underline{1}|$ (upper appliance incorporating a spring arm labially to bear on mesiolabial corner of $\underline{1}|$).

Acknowledgements.—It is desired to make full acknowledgement to Mr. J. D. Hamilton Jamieson as the originator of the appliance.

I wish to thank my colleagues, Mr. D. A. Dixon and Mr. D. M. Menezes, for two of the clinical cases used in the demonstration; I would also like to thank Mr. W. Duncan and Mr. G. Richardson for the construction of the demonstration and Mr. D. C. Standen for the photographs.

TEACHING IN PLASTIC

By **MICHAEL F. SCOTT**, L.D.S. R.C.S.

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THE manufacture of acrylic resins in sheet form can be used for the construction of working models to illustrate on a large scale aspects of orthodontic problems.

The first model was designed to show a phase in the physiology of tooth movement. It consisted of a sagittal section of an incisor tooth, with periodontal membrane and alveolar bone. At rest, it showed the normal position of a tooth in bone (*Fig.* 1), and when activated the areas in which bone is resorbed and deposited in response to tooth movement (*Fig.* 2).

The second model illustrated the relationship of incisor teeth to soft tissue morphology, in sagittal section (*Fig.* 3). Normal relationship could be illustrated, and with the same model incompetent lips and tongue thrust could be shown to affect the relationship of the incisors (*Fig.* 4).

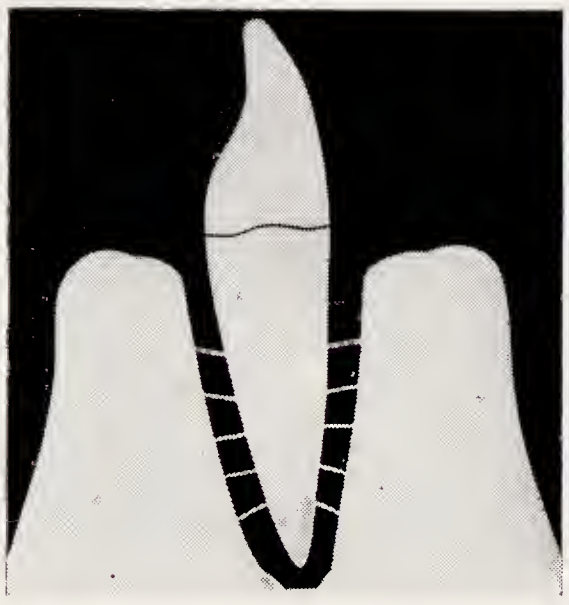

Fig. 1.—Normal relationship of incisor to alveolar bone.

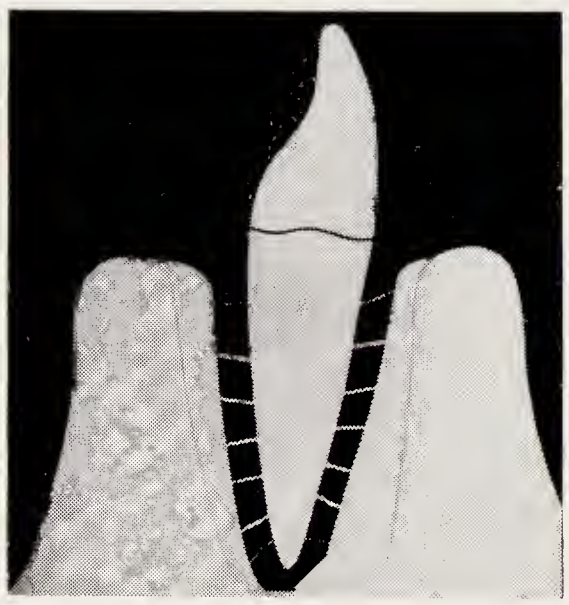

Fig. 2.—Proclined incisor showing resorption and deposition of alveolar bone.

Fig. 3.—Normal relationship of incisors to soft tissues.

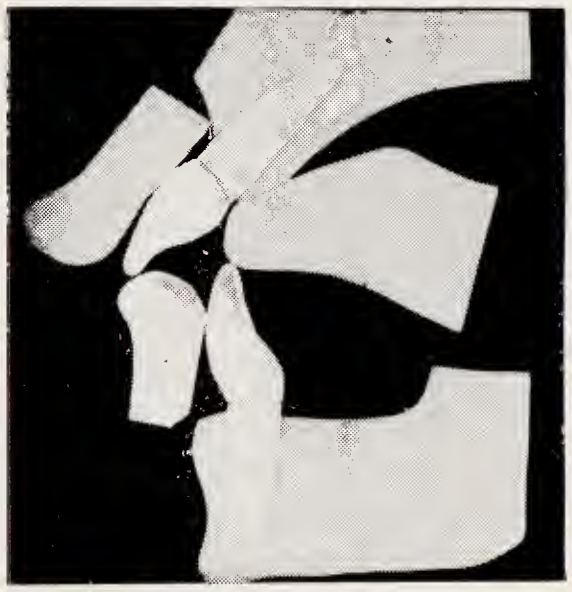

Fig. 4.—Effect on incisors of tongue-thrust and incompetent lips.

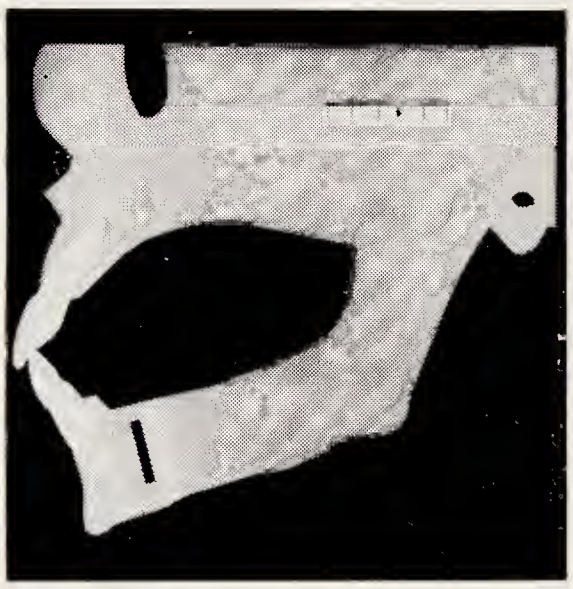

Fig. 5.—Normal axial inclination of incisors to Frankfort and mandibular planes.

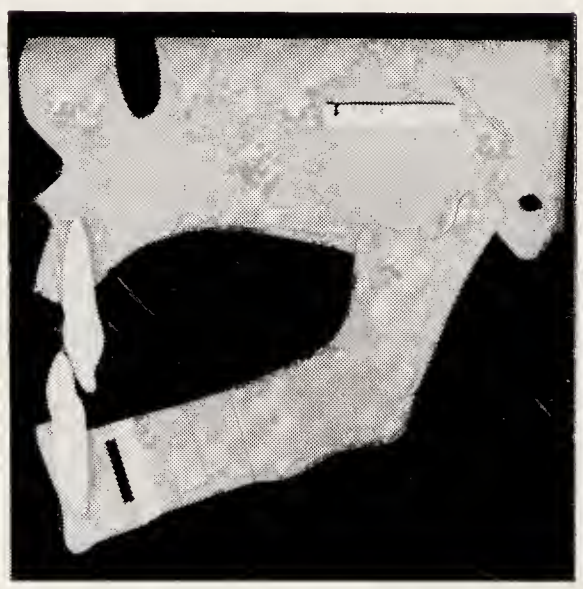

Fig. 6.—Retroclination of incisors: the degree of retroclination is shown on the respective scales.

The last model was built up from a lateral skull X-ray taken in a cephalostat, of a patient who had normal incisal angulation to the Frankfort plane and mandibular plane (*Fig.* 5). This model could be activated to show proclination and retroclination of the incisor

A demonstration given at the Jubilee Meeting held on May 10, 1958.

teeth, and the degree of angulation to their respective planes could be read on two scales incorporated into the model (*Fig.* 6). The mandible could also be moved to indicate prenormal and postnormal relationships.

All the models were made from coloured acrylic sheet $\frac{1}{8}$ in. in thickness, and $\frac{1}{4}$ in. thickness for the black background. Each model was approximately two feet in height. The moving parts were attached to the base by nuts and bolts and were activated by stainless steel wire. The glue used was a mixture of chloroform and clear polymer.

The models were used to demonstrate some specific aspects and problems connected with orthodontics to groups of 10–15 persons at one time.

Acknowledgements.—My thanks are due to the technicians of the Dental Laboratory, City General Hospital, Stoke-on-Trent, for constructing the models, and to Miss Roberts, Clinical Photographer, Wordsley General Hospital, for the photographs.

CLASS III CASES WITH FAILURE OF VERTICAL DEVELOPMENT

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SEVEN cases are presented to demonstrate the existence of a type of Angle Class III malocclusion which is distinct from either the true skeletal or postural types.

Before undertaking a description of these cases it is necessary to understand the mechanism and underlying aetiology of the normal postural Angle Class III malocclusion. A most comprehensive analysis is given by Ballard (1955). Briefly, it is thought that postural Class III cases have morphological factors which are common to other types of Class III cases, but to a lesser degree, resulting in an edge-to-edge bite in the labial segments in the normal path of closure. The mandible displaces forward as a reflex movement in mastication and speech to avoid this contact, and the occlusal position is shown to be a true overclosure. The initial contact on closure from rest to occlusion is one not normally made in function, contacts made during idle movements being sufficient to maintain the habit pattern (Ballard, 1954). When the abnormal incisor relationship is corrected, Ballard has shown that the occlusal level is altered and the maxillary/mandibular plane angle with the teeth in occlusion opens. Before treatment there is shown to be an excessive interocclusal clearance which decreases after treatment, and this supports the view that the overclosure is a direct result of the displacing activity.

Ballard (1955) further investigates the condyle position in these Class III cases. The methods available for examination of condylar movement are detailed, and results using Nevakari's method (1954, 1955) are shown. The condyle is demonstrated to be in a very similar position in the occlusal radiographs as in the rest position ones—and is not forward in the glenoid fossa. Rotation of the mandible carries the condyles back after the forward disengaging movement.

Hopper (1955) also shows little resultant condylar movement in his investigation of postural Class III cases.

I have come across a number of cases that do not conform to the above description and do not respond in the way described. They seem to form a separate clinical entity, and are now demonstrated.

CLINICAL PICTURE

This shows a Class III occlusion in which a postural component is present, but where there is additionally a failure of vertical development

Based on a demonstration given at the Jubilee Meeting held on May 10, 1958.

in the buccal segments. An increased inter-occlusal clearance exists which appears to be due to a primary failure of vertical development, and is not secondary to that produced by a displacing activity of the mandible

without a displacement being induced. To achieve an occlusion there is a conscious disengaging movement of the mandible. I have in mind, therefore, that there are two types of disengaging or displacement movement of the

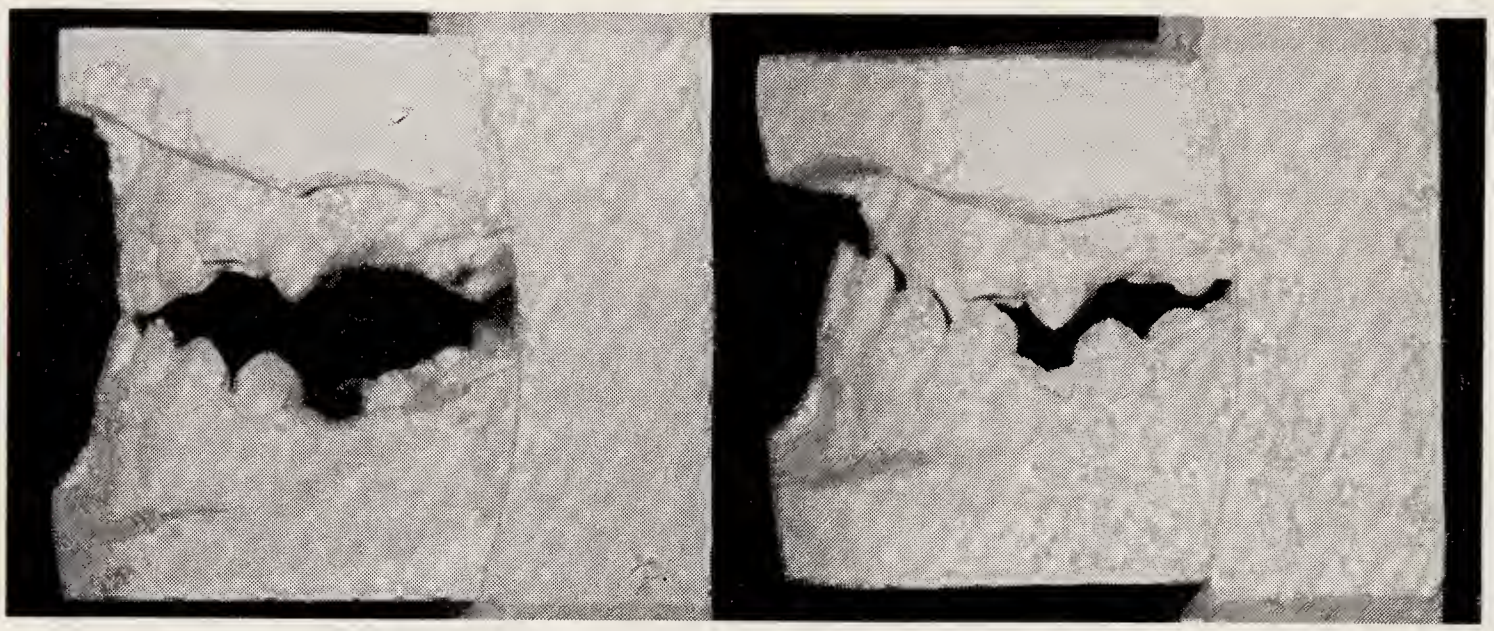

Fig. 1.—Models showing initial incisor contact and protrusive occlusion.

Fig. 2.—Profile view at rest, and in occlusion.

(*Fig.* 1). There is a mild Class III dental-base relationship. There is often what might be termed a "solid contact" on the incisors, with perhaps wear facets on the incisal surfaces of these teeth, and the mandible does not normally move forward as a habit-avoiding activity in speech. I use the term "solid contact" to distinguish it from the soft type of contact which often indicates a displacement, and showing facets on the labio-incisal surfaces of the upper incisors. In the cases described, the incisors may meet edge-to-edge

mandible: the first based on Ballard's concept of the reflex avoiding activity, and the second as I have described, with no habit movement. Whether the second follows the first merely as a matter of degree of edge-to-edge incisor relationship is not certain; I am inclined to think not and to associate it more with the failure of vertical development. It is possible that the developmental failure has to some extent included the labial segments, so that in these cases the rest position is open from the initial incisor contact. This is in

contrast to the postural type of case where the true rest position may be somewhere closed from the initial incisor contact, a condition which could very well predispose to a habit-avoiding activity of the mandible in function. Clinically, the patient's profile shows overclosure when occluding on the posterior teeth, and photographs of one case are shown to illustrate this (*Fig.* 2). An interesting feature is that most of these cases present marked wear facets on the occlusal surfaces of the molars, and a history of bruxism is elicited. This fits in with one of the possible explanations of the aetiology of bruxism, which states that it is a subconscious attempt on the part of the patient to eliminate occlusal interferences (Ballard and Grewcock, 1954). The fact that it may take place with the mandible held forward out of its normal centric relationship should be noted.

The clinical examination is most important, and all cases must be analysed from the rest position; one can try then to decide where the deficiency is. Although there is no water-tight separation, Angle Class III cases will roughly fall into one of the following categories:—

1. True skeletal.
2. Postural, with increased interocclusal clearance, this being attributed to the mandibular displacement.
3. Postural, with excessive interocclusal clearance and clinical overclosure, greater than can be attributed to the displacement of (2).

RADIOGRAPHIC AND CEPHALOMETRIC PICTURE

The usual features of Class III cases are seen: a Class III dental base relationship, often a short maxillary apical base, with overcrowding. In addition, it can be plainly seen that there is little depth to the maxilla in the premolar and molar region. A reverse "Curve of Spee" exists. This, of course, could be produced merely by overdevelopment of the labial segments, hence the need to assess the case in the rest position. The increased interocclusal clearance is coupled with a low maxillary/mandibular plane angle with the teeth in occlusion, but not necessarily with a low gonial angle.

Brodie (1941) has stated that nasal height contributes 43 per cent of the total face height, and the cases demonstrated show that the lower part of the face is about 5 per cent less than it would be according to Brodie's figure. Meredith, Knott, and Hixon (1958) query Brodie's analysis and give a different set of figures related to age; my cases also demonstrate a subnasal insufficiency when compared with these.

CONDYLE MOVEMENT

A method of assessment of condyle movement has been evolved which appears to be at least as accurate as any other method in use at the moment, and does not require any special temporo-mandibular joint radiographic technique. The method is used in conjunction with the tracings obtained with the usual cephalometric skull radiographs. Using a compass with the point on the tip of the lower incisors on the occlusal tracing, an arc is cut across the mandibular plane, somewhere in the region of gonion. The compass is also used at the same setting to describe an arc in the region of the condyle. The set compass then reproduces similar arcs on the rest position tracing. The compass is next used at any setting to cut a chord from the point obtained on the mandibular plane across

Fig. 3.—Cephalometric tracings of a patient, showing movement of condyle when mandible moves from rest to occlusion.

the arc in the condyle region, and this is again reproduced in the rest position tracings. An intersection of arcs is thereby produced in the condyle region which exactly superimposes when the mandibles themselves are superimposed. Superimposition of the occlusal and rest position tracings now shows very clearly what happens to the point in the condylar region when the mandible moves from rest to occlusion (*Fig.* 3). Rotation only was apparent in 2 cases; translation occurred as an additional movement in 3 cases. One of these presented a 4-mm. forward and downward movement of the condyle on to the eminentia articularis. Two cases exhibited a slight forward and upward movement; the latter could be explained by the shape of the condyle. The other cases have not been the subject of a radiographic analysis.

AETIOLOGY

Vertical growth of the maxillary dento-alveolar structures, or vertical growth of the maxilla as a whole, appears to have failed to keep pace with growth in depth of the total facial complex. The basis behind this failure of development can only be a matter for conjecture. A genetic factor is suspected; it may not, indeed, be a "failure" at all, but merely part of a morphological pattern. Is it similar to the vertical development failure of the maxilla in some cleft palate cases? Evidence is being accumulated that it is an additional aetiological factor which may be localized or more extensive and shown on any skeletal pattern.

The writer has two true Class III cases under observation at the moment where it is not possible for the upper and lower incisors to meet. Both cases have been diagnosed as possessing the additional factor of failure of development in the buccal segments. In each case the parent has insisted that the child could bite edge-to-edge before the deciduous incisors had been lost, and that the "growing forward of the lower jaw" has become more and more noticeable since this time. Each case overcloses to achieve an occlusion and presents the increased inter-occlusal clearance previously described. It is not possible to state when a cessation of vertical development first becomes manifested, but if in the two cases just referred to it started at the time the first deciduous teeth were being shed, then this would fully explain the symptoms which had been causing the parents concern; the progressive mandibular prognathism is attributable not to an increased growth of the mandible in relation to the maxilla, but purely to the fact that in overclosing now, the anterior part of the mandible must swing upwards and *forwards* in relation to the maxilla.

TREATMENT

The principle of treatment will be to eliminate the displacement and build the level of the occlusion to a position which would be normal in relation to the rest position of the mandible. It must be assumed that the rest position is correct, and that the error lies entirely in the occlusal position.

1. Elimination of overcrowding by extractions.

2. Alteration of incisor relationship. Although the upper incisors might be proclined a little, they cannot be moved too far forward because of the lip. If the upper incisors are moved forward out of their stable position between the lip and tongue, then the lip will, during the course of its normal function, tend to move the incisors lingually again. If, however, the lower incisors are now preventing them from moving lingually, a traumatic bite relationship will have been established, and the upper incisors will become loose (Ballard, 1953). They may show an increased thickness of the periodontal membrane with later root resorption. The lower incisors must, therefore, be retracted.

3. If the overclosure had been entirely due to the displacing activity of the mandible, elimination of the initial contact would allow the buccal segments to develop vertically into contact. It is at this stage that the cases exhibiting vertical failure become most apparent; the incisors are in a reasonable position, but the buccal teeth remain out of occlusion (*Fig.* 4).

It may be argued that a lateral ooze of the tongue is preventing the cheek teeth from

occluding. I sometimes fit, at this stage, an upper removable appliance with anterior bite plane to hold the newly achieved incisor relationship—worn in the daytime. An Andresen appliance is also constructed in the retruded bite position to hold the labial segments, and trimmed vertically in the buccal segments to permit eruption of the cheek teeth; this alternates with the bite plane and is worn in the evenings and at night.

The corrected incisor relationship needs to be held for some considerable time, until it can be certain that no vertical development is taking place. It would be a great error of treatment to take out all appliances at this stage to allow the occlusion to "settle". This may only result in incisor trauma and attainment of an all-round occlusion by a return to the overclosed position.

4. If in the treatment of the case the upper incisors have been proclined, they must be supported from the lingual aspect (*Fig.* 5). An overlay splint must then be constructed to bring about full occlusal contact. One must be certain that such a splint does not encroach upon what would be a reasonable interocclusal clearance (*Fig.* 6). This is assessed clinically, taking as a starting-point the rest position of the mandible.

A B C

Fig. 4.—Models showing A, Initial occlusion; B, Incisor relationship corrected with a posterior open bite; C, Final occlusion with onlay denture.

Fig. 5.—Splint to support the proclined upper incisors.

Fig. 6.—Front view of upper splint, and overlay splint in the mandibular arch.

As an initial treatment procedure, in some cases I am fitting a Sved type bite plane appliance prior to undertaking any active tooth movement, merely to prevent an overclosure taking place. This is to confirm that the failure of vertical development is the cause and not the result of the overclosure, and that no vertical growth takes place even if the overclosure is prevented.

CONCLUSION

A case is demonstrated showing the result of this treatment procedure. The splints shown

in *Fig.* 6 have been in situ now for more than two years. The dentition is perfectly healthy and a very careful and complete cephalometric analysis covering the treatment and post-treatment period shows that there has been no intrusion of the teeth covered by the overlay splint.

One may ask if it is wise to subject a patient to such permanent appliances; would it not be better to leave the original malocclusion? What is accomplished by such treatment? First of all, a great improvement in appearance is produced. Then, secondly, one gives the patient a functional occlusion which is far more efficient than the original. Finally, one is eliminating the possibility of temporomandibular joint disturbances arising later as a direct result of the overclosure.

It is not claimed that these cases can necessarily be differentiated with certainty at the diagnostic stage. An awareness of the existence of this type of case is what is necessary to explain the "development" of a posterior open bite when the incisors are corrected, and will indicate the possibilities of treatment.

Acknowledgements.—I am very grateful to my patients for travelling so far to enable special records to be made, to the Radiographic and Photographic Departments of the Eastman Dental Hospital, and to Professor C. F. Ballard for his great interest in this material, and for permission to publish the treated case which was completed at the Eastman Dental Hospital, London.

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THE DEVELOPMENT OF A MALOCCLUSION

A SERIAL STUDY FROM 8 WEEKS TO 9½ YEARS OF AGE

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MATERIAL

The material for this study consists of a series of 20 casts of the same child from 8 weeks through 9½ years. Apart from the first 2 casts, impressions were taken following the eruption of a tooth or teeth.

Dates and Sequence of Eruption.—Teeth were recorded as erupted when enamel was visible. The order and dates of eruption are shown in *Table I*.

Apart from their interest as an individual record of eruption the only noteworthy point is the eruption of the upper deciduous laterals 10 weeks before the lower deciduous laterals, a reversal of the usual order. The deciduous incisors appear to be more variable in their order of eruption than the permanent incisors. I have previously recorded (Hopkin, 1945) 2 cases where the upper central incisors were the first teeth to erupt, and 2 cases in the same family where the upper lateral incisors were the first teeth to erupt. I have recently seen another case where the eruption of the right upper lateral incisor followed the eruption of the lower central incisors.

These variations appear to have no significance in relation to the development of the occlusion.

OBSERVATIONS ON THE DEVELOPMENT OF THE OCCLUSION

Anteroposteriorly.—The relationship of the upper jaw to the lower jaw, as shown by the occlusion of the gum pads prior to the

Based on a demonstration given at the Country Meeting held at Newcastle upon Tyne on May 12, 1956.

establishment of the deciduous molar occlusion, was determined by observation.

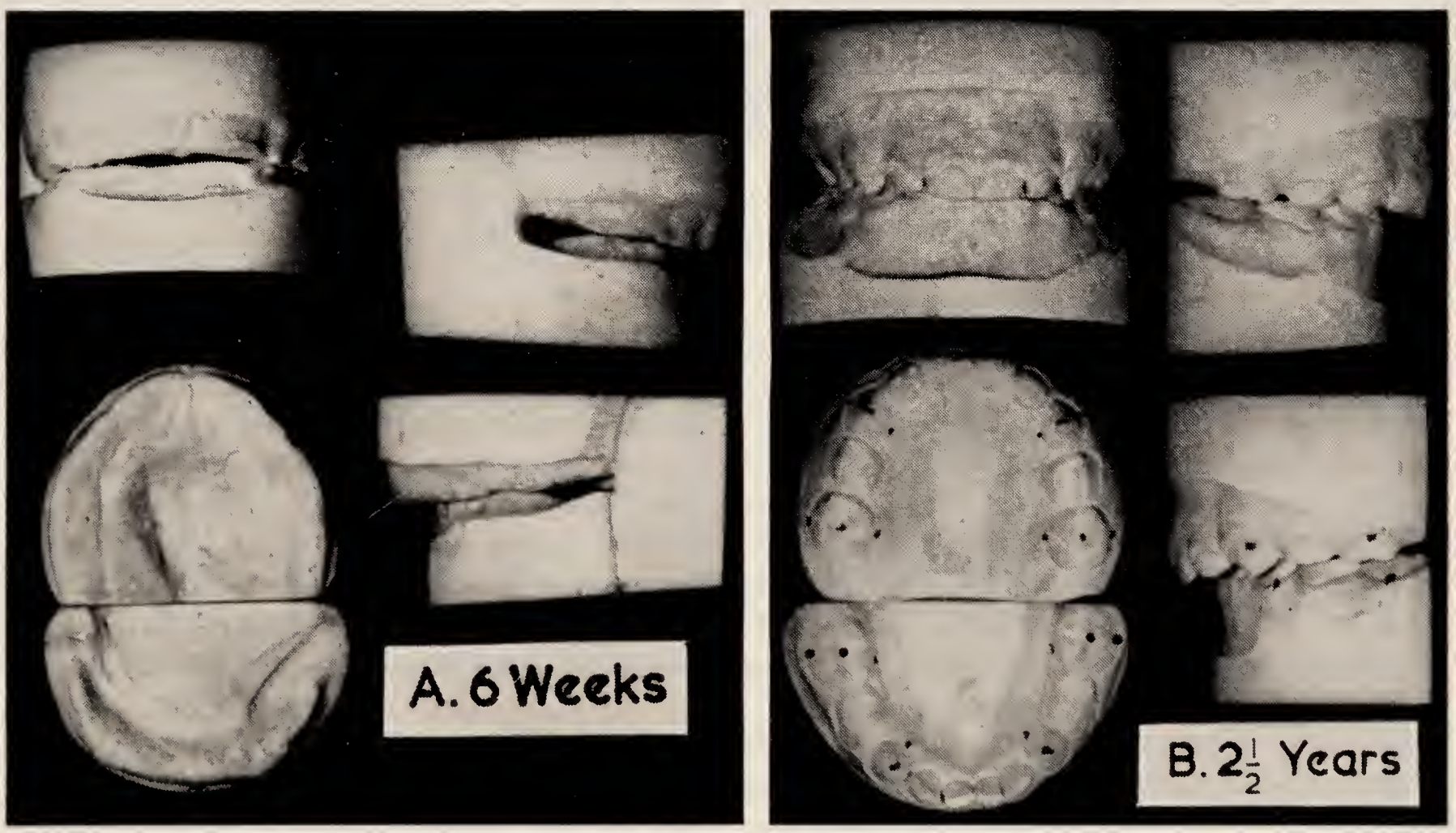
At 6 weeks the mandible was in a distal relationship to the maxilla and there was a small symmetrical anterior space 1 mm. or less in height (*Fig.* 1 A). The absence of any space, according to Clinch (1938), presages an excessive overbite, although Baume (1950 a) does not consider the space is related to the overbite. Anteroposteriorly there was an overjet of 4–5 mm. which was still present at 7 months, with the eruption of the upper and lower deciduous central incisors. At 19 months, when with the establishment of the occlusion of the first deciduous molars in a distal relationship the overjet proper could be measured, the overjet was 6 mm.

At $2\frac{1}{2}$ years, when the deciduous dentition was complete, the lower canines and second molars being in marked disto-occlusion, the overjet was 6 mm., which remained unaltered until the shedding of the deciduous incisors (*Fig.* 1 B).

These observations indicate that the distal relationship of the mandible to the maxilla was either determined before birth or that there was a failure of mandibular forward growth to overtake the maxilla as described by Sillman (1938) as normal during this period. There was no history of nutritional disturbance to check growth during that

Table 1.—Order and Dates of Eruption

Deciduous		Permanent		
Tooth	Mth.	Tooth	Yr.	Mth.
$\overline{A\|A}$	7	$\|\underline{6}$	5	8
$\underline{A\|A}$	8	$\underline{6}\|$	6	0
$\underline{B\|B}$	$10\frac{1}{2}$	$\overline{6\|6}$	6	2
$\overline{B\|B}$	13	$\overline{1}\|$	6	5
$\underline{D\|D}$ $\overline{D\|D}$	$16\frac{1}{2}$	$\|\overline{1}$	6	6
$\underline{C\|C}$ $\overline{C\|C}$	19	$\overline{2\|2}$	7	10
$\underline{E\|E}$ $\overline{E\|E}$	24	$\underline{1\|1}$ $\underline{4}\|$	8	0
		$\|\underline{2}$	8	9
		$\underline{2}\|$	9	1
		$\|\underline{5}$ $\|\underline{4}$	9	5

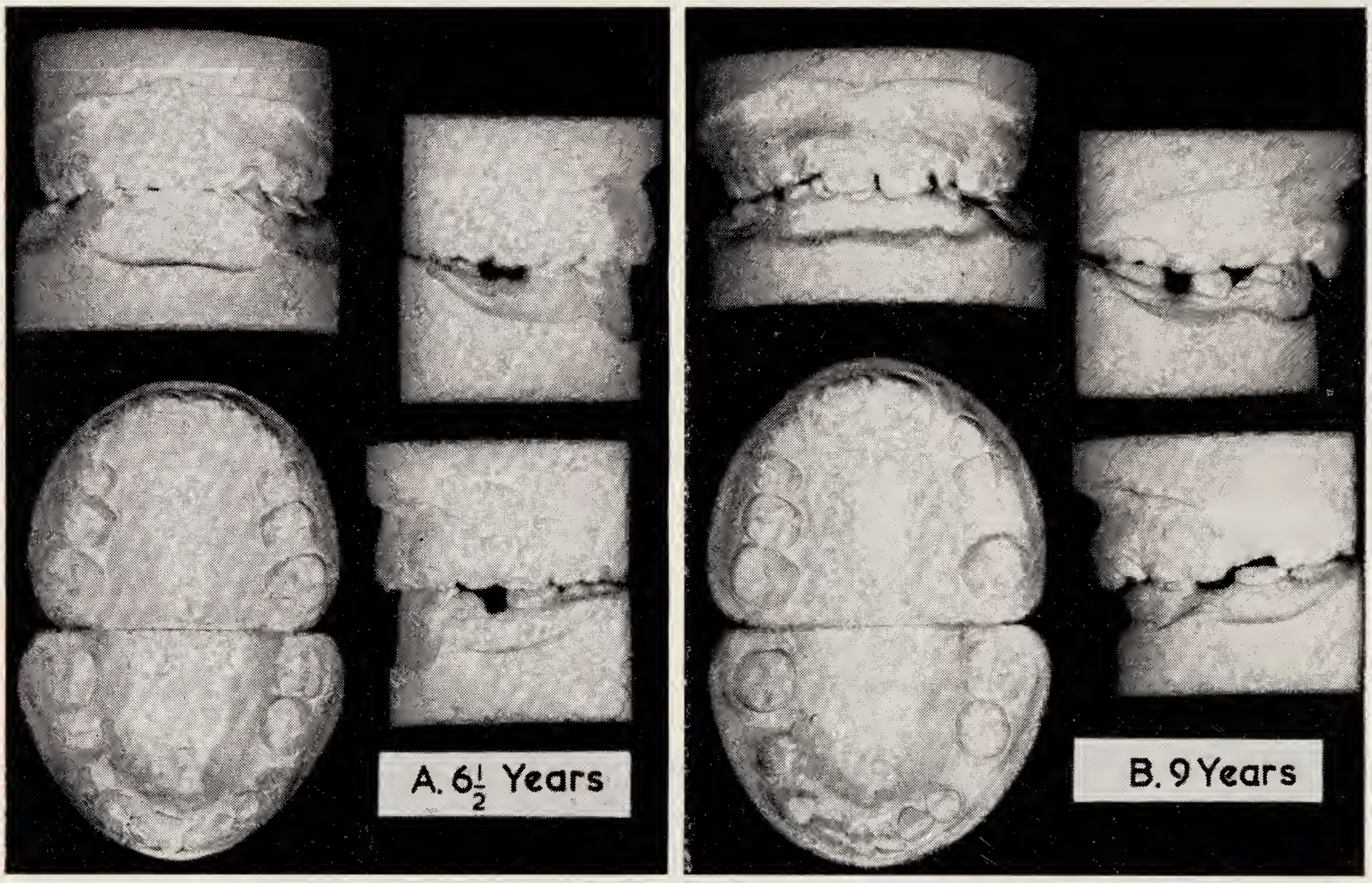


A B

Fig. 1.—A, Distal relationship of lower gum pad to upper gum pad and symmetrical anterior space at 6 weeks. B, Bilateral disto-occlusion with excessive overjet and overbite at $2\frac{1}{2}$ years. The occlusal view shows the points of measurement.

period, nor were there any sucking habits which are believed by Nord (1955) to produce a disto-occlusion. The persistence of the overjet from $2\frac{1}{2}$ to 6 years shows the absence of any relative physiological mesial shifting of

Vertical.—With the eruption of the deciduous incisors an excessive overbite appeared (*Fig.* 1 B), which persisted following the replacement of the deciduous incisors by the permanent incisors (*Fig.* 2 B). The overbite



A B

Fig. 2.—A, Occlusion of $\frac{6}{6}|\frac{6}{6}$ in a distal relationship at $6\frac{1}{2}$ years. Note the marked attrition of the deciduous incisors. B, Dentition at 9 years. Note excessive overbite $\underline{1|1}$, mesial drift of $\overline{6|}$ and distal deflection of $\overline{4|}$ due to retained root of $\overline{D|}$.

the mandible or mandibular teeth during this period, as described by Friel (1938) in the development of normal occlusion. The excessive overbite, which might have prevented a mesial mandibular shift, was reduced by the excessive attrition of the incisor teeth that occurred due to the child indulging in bruxism or night grinding; when the mandible was protruded an edge-to-edge occlusion was obtained.

The first permanent molars were in full occlusion at 6 years 5 months, showing a distal relationship (*Fig.* 2 A). With the full eruption of the central incisors there was an overjet of 5 mm., and the malocclusion was classified as Angle's Class II, division 1.

showed an apparent improvement in the later period of the deciduous dentition due to the marked attrition of the incisors (*Fig.* 2 A).

Breadth.—Before discussing the increase in breadth of the arches as shown by the measurements of intercanine and molar breadths, it is convenient to discuss the question of the spacing of the upper deciduous incisors. This has been thought to be related to the increase in the intercanine width and to occur prior to the eruption of the permanent incisors; Baume (1950 b), however, states that the incisors are either spaced or unspaced and do not alter.

The upper central incisors were spaced on eruption at $10\frac{1}{2}$ months, and there were spaces

between all the upper incisors following the eruption of the laterals at 13 months. The spaces had been reduced by 16 months and were closed up completely at 2 years with the

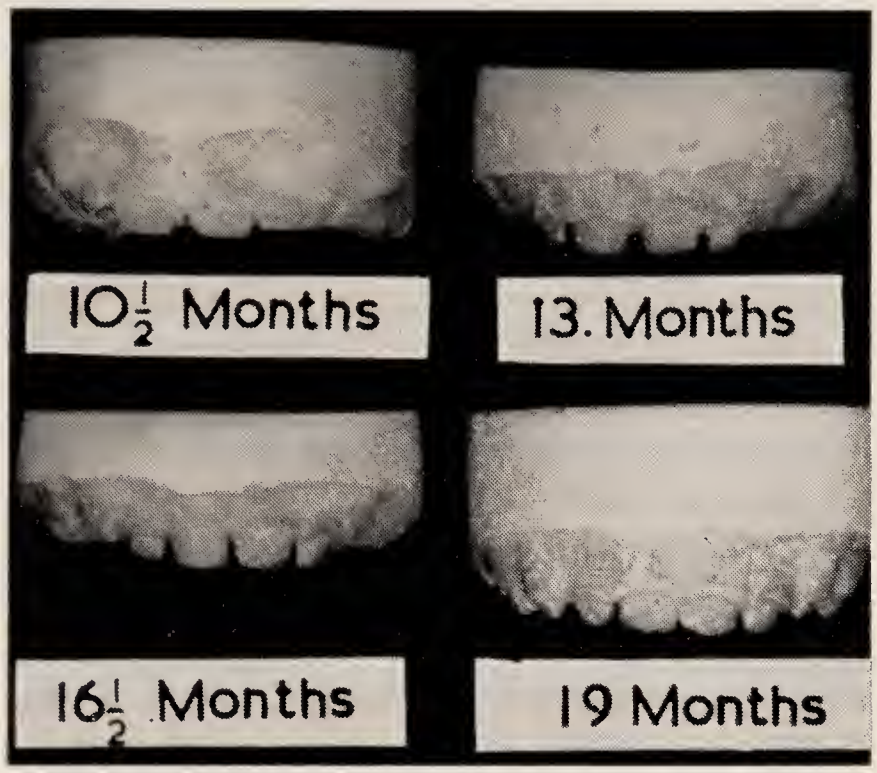


Fig. 3.—Spacing of deciduous incisors on eruption followed by closure of the spaces.

eruption of the canines (*Fig.* 3). (Spaces reappeared later due to the excessive attrition of the incisors beyond the contact points.)

This pattern of events is similar to that which occurs during the eruption of the permanent incisors, which, in this case, showed at 8 years a small developmental space between the permanent central incisors after eruption which lessened with the eruption of the lateral incisors around 9 years, and which has decreased further with the full eruption of the laterals by 9½ years.

The increases in arch breadth, as indicated by the measurements described below, were recorded between the deciduous canines, the second deciduous molars, and the first permanent molars; three measurements were taken for the following reasons: as a check, to provide comparable data with other series, and with regard to the lower canines to see whether this case agreed with the findings of Clinch (1951), referred to later.

MEASUREMENTS

Measurements of arch breadth were taken between the following teeth in each jaw: (1) Deciduous canines; (2) Second deciduous molars; (3) First permanent molars.

The points of measurement used were as follows:—

1. Deciduous Canines.—

a. External.—Greatest width at the buccal gingival margin.

b. Cusp.—The tips of the cusps or the centre of the occlusal surface where the cusp tip had been worn away.

c. Internal.—The centre of the base of the cingulum at the gingival margin.

2, 3. Second Deciduous Molars and First Permanent Molars.—

a. External.—The point where the buccal groove or its production intersected the gingival margin.

b. Occlusal.—The anterior occlusal pit in the upper molars and the centre of the central fossa in the lower molars.

c. Internal.—The centre of the base of the anterior palatal cusp at the gingival margin in the upper molars and of the anterior lingual cusp in the lower molars.

The measurements were made to the nearest half millimetre with a pair of fine-pointed spring bow dividers and a sliding calliper.

The various measurements are tabulated in *Table II.*

1. Intercanine Breadth.—A comparison with the comparable figures of Goldstein and Stanton (1935) and of Cohen (1940) for intercanine width shows a general agreement as regards measurements and periods of increase.

Chapman (1934) reports an increase of 4 mm. in upper intercanine width measured between the buccal surfaces between 5 years 7 months and 9 years 5 months in a case of normal occlusion. Clinch (1951) records the greatest mean increase of intercanine width during the eruption of the permanent incisors. The increase in the upper arch in this case was 4·5 mm. between 2½ years and 9 years; of this 2 mm. occurred between 2½ and 5½ years, followed by a period of relative stability till 7–7½ years. From 7½ to 9 years there was an increase of 2½ mm., which means that growth was twice as rapid during the eruption of the central incisors as it was from 2½ to 5½ years. The consensus of opinion is that the period of greatest increase in intercanine width is during the eruption of the incisors.

Whilst in the upper jaw the measurements of breadth made at the three points agree to within half a millimetre, there is greater difference in the lower arch where the internal

Table II.

INTERCANINE WIDTH IN MM.

AGE		UPPER			LOWER		
Yr.	Mth.	Ext.	Cusp.	Int.	Ext.	Cusp.	Int.
2	6	33·5	28·0	21·5	28·0	22·0	17·0
5		34·5	29·0	22·5	28·5	23·5	17·0
5	8	35·5	30·0	23·0	29·0	23·5	18·0
6		35·5	30·0	23·0	29·0	23·5	18·0
6	5	35·5	30·0	23·0	29·0	24·0	18·0
7	6	36·0	30·0	23·5	30·5	25·0	18·5
8		37·0	31·0	24·0	30·5	25·5	19·0
8	9	38·5	32·5	25·5	31·0	26·0	19·0
9	1	38·5	32·5	26·0	31·5	26·0	19·0
Total increase		5·0	4·5	4·5	3·5	4	2·0

INTERMOLAR WIDTH, E–E IN MM.

AGE		UPPER			LOWER		
Yr.	Mth.	Ext.	Cusp.	Int.	Ext.	Cusp.	Int.
2	6	43·0	34·5	24·0	43·0	33·0	26·0
5		45·5	37·0	26·0	44·0	34·0	26·5
5	8	45·5	37·0	26·0	44·0	34·0	26·5
6		46·0	37·5	27·0	—	—	—
Total increase		3·0	3·0	3·0	1·0	1·0	0·5

INTERMOLAR WIDTH, 6–6 IN MM.

AGE		UPPER			LOWER		
Yr.	Mth.	Ext.	Cusp.	Int.	Ext.	Cusp.	Int.
6	5	51·5	41·5	28·5	50·5	39·5	31·0
7	5	51·5	41·0	28·0	51·5	38·5	29·5
8		51·5	41·0	28·0	51·5	38·5	29·5
8	9	52·5	42·0	29·0	51·5	38·5	29·5
9	1	52·5	42·5	29·0	51·5	30·0	3p·0
Total increase		1·0	0·5	0·5	1·0	0·5	0·5

width increased 2·0 mm., the cuspal 4·0 mm., and the external 3·5 mm. This agrees with Clinch's (1951) observations, who considers the difference to be due to an increased labioclination of the canines.

A comparison with the intercanine measurements of Lewis and Lehmann (1929) shows that the figures for the upper arch approximate the mean of Lewis's normal cases, e.g., 28·0 mm. at $2\frac{1}{2}$ years (Lewis, 28·11 mm.) and 32·5 mm. at $8\frac{1}{2}$ years (Lewis, 33·0 mm.), whilst the figures of the lower arch exceed those of Lewis at the later ages, 25·55 at $2\frac{1}{2}$ years (Lewis, 25·75 mm.) and 29·5 mm. at $8\frac{1}{2}$ years (Lewis, 28·17 mm.). (The measurements of the lower arch were made using Lewis's points, the upper arch points being the same, i.e., cusps of canines.)

Lewis also gives the mean intercanine widths for some Angle Class II, division 1 cases, the upper arch only being measured. A comparison with these figures shows the upper arch in the present case to be wider at all ages recorded, 28 mm. at $2\frac{1}{2}$ years (Lewis, 25·75) and 29 mm. at 5 years (Lewis 26·01 mm.), but the lower arch breadth in this case exceeded Lewis's mean figures for normal cases. This emphasizes that it is the proportion of upper arch breadth to lower arch breadth in the individual case that is of importance, not its relation to the mean of a series.

2. Second Deciduous Molar Widths.—It was not possible to ascertain deciduous molar widths for more than 4 years because of the premature loss of some of these teeth. In the period covered, $2\frac{1}{2}$–6 years, there was an increase of 3 mm. in the upper second deciduous molar breadth. This compares with the mean increases over approximately the same period, 3–6 years, recorded by Lewis, 0·89 mm., and by Cohen, 0·9 mm. These figures underline the extent of individual variations in growth which, while a matter of common observation as regards general bodily development, are apt to be obscured under a mass of statistics in occlusal studies.

3. First Permanent Molar Widths.—The width between the permanent molars increased only 1 mm. or less between $6\frac{1}{2}$ years and 9 years. In both upper and lower arches there is 0·5 mm. difference between the external and the occlusal and internal measurements, as regards total increase. In the lower arch, between $6\frac{1}{2}$ and $7\frac{1}{2}$ years, there is

a decrease of 1–1·5 mm. in arch breadth, according to the occlusal and internal measurements, whilst externally an increase of 1·0 mm. is registered. It is thought that this discrepancy, and the minor discrepancy in total increase referred to, may be due to the external measurements being affected by the further exposure of the clinical crown with its sloping buccal surface, an increase of 2 mm. in the depth of the clinical crown being noted over this period. This would offset the decrease in width, as shown by the other two measurements, due to the mesial drifting of the right lower first permanent molar, which took place during this period as is described later.

LOSS OF SPACE FOLLOWING PREMATURE EXTRACTION OF DECIDUOUS MOLARS

1. Loss of $\overline{ED}|$.—There was a loss of 1 mm. following the onset of interstitial caries with destruction of the contact point between the molars between 5 and $5\frac{1}{2}$ years. $\overline{6}|$ erupted 2 months after the extraction of $\overline{E}|$ at 6 years, and the greatest space loss appears to have occurred following the full eruption of the permanent molars with the coming into play of the mesially directing forces of occlusion, the total space loss by $7\frac{1}{2}$ years being 3·5 mm., and this has remained unaltered up to $9\frac{1}{2}$ years.

2. Loss of $|\frac{E}{D}$.—These teeth were lost at $6\frac{1}{2}$ years, 1 mm. of space was lost earlier in the upper segment due to interstitial caries. This space was not regained by the restorations placed in these teeth. Following the loss of $|\underline{E}$, no further space was lost till $8\frac{1}{2}$ years, when a loss of 0·5 mm. occurred, giving a total loss of 1·5 mm. in the upper segment. In the lower segment 0·5 mm. was lost, due to interstitial caries, but there was no further loss till $8\frac{1}{2}$ years, when the space decreased by 1·0 mm., giving a total loss of 1·5 mm. equal to the upper. The greater stability on this side of the jaw as compared with the opposite side was probably due to the fortuitous loss of alternating teeth in the upper and lower segments, the remaining teeth interlocking to hold the spaces, a natural method of space maintenance apt to be overlooked if individual arches alone are considered.

SUMMARY

The development of an Angle's Class II, division 1 malocclusion from 6 weeks to $9\frac{1}{2}$ years is described. The establishment of the disto-occlusion is suggested as occurring antenatally or in the early postnatal period, no adverse postnatal environmental factors being discovered.

The aetiology of the condition must therefore be sought either in genetic or prenatal factors. As both parents had Angle Class II, division 1 malocclusions and all 3 individuals on cephalometric analysis show a Class II (Ballard) skeletal pattern, the genetic factor would appear to be the most important.

Eruption dates are recorded; a difference in the usual order of eruption of the deciduous upper incisors is described, together with a developmental pattern of eruption similar to that of permanent upper incisors.

Growth in width of the arches is discussed principally in respect of the intercanine width and comparisons made with previously published data.

Space closure, following the loss of some of the deciduous molars, is described, and the value of "natural" space maintenance noted.

Acknowledgements.—I am indebted to Mr. W. Duncan for this series of models which he has presented to the Orthodontic Department, and I would like to express my appreciation of his interest and enthusiasm. I wish to thank Mr. C. G. Standen, of the Dental Photographic Department, for the photographs and last, but not least, I am indebted to the patient for cheerfully submitting to the many impressions required.

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VESTIBULAR ANCHORAGE: A CLINICAL EXPERIMENT

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THE usual sources of anchorage are not always adequate or convenient for the tooth movements required for the correction of the more difficult types of malocclusion.

Simple anchorage utilizing teeth in the same arch is often insufficient for major tooth movements. Intermaxillary anchorage may cause unwanted reciprocal movements in the opposing arch and thus lead to crowding and arch instability. There is therefore an increasing tendency at present to resort to cervical or occipital traction in difficult cases. However, this usually involves a lengthy treatment period to produce an acceptable amount of tooth movement, and also tends to encounter patient-resistance as it is an unsightly and complicated mechanism.

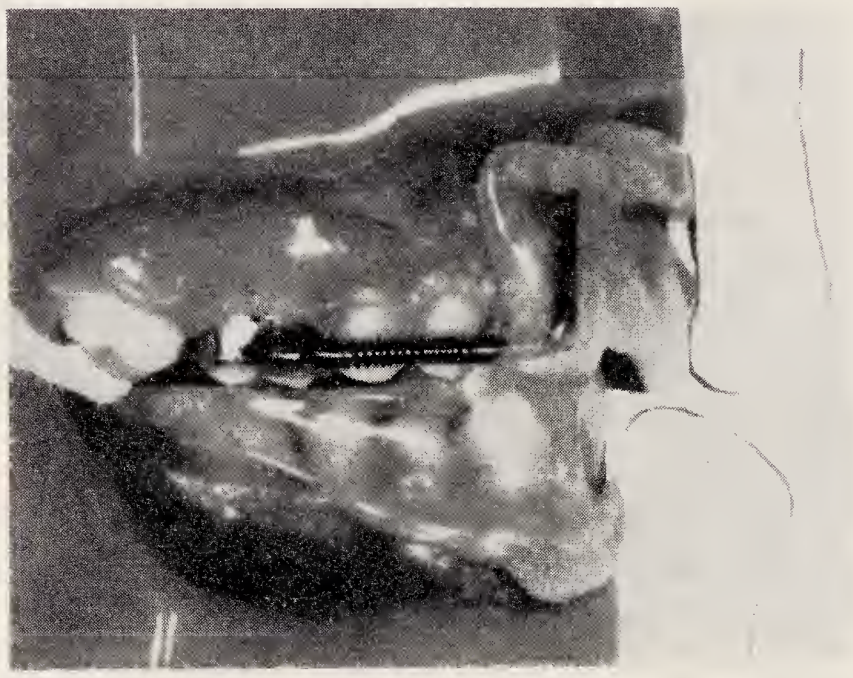

Fig. 1.—Lateral view of appliance.

The appliance illustrated in *Fig.* 1 was designed in an attempt to utilize the stability of the rest position of the mandible and the activity of the circumoral musculature to provide an anchorage from which orthodontic forces could be exerted and tooth movements produced. The appliance is constructed in two parts. The lower part consists of a flange fitting into the lower labial sulcus and having distally an occlusal extension opening the bite some 2 mm. The upper part also has a labial flange into which distally is embedded a 1·5 mm. wire; this passes through tubing soldered on the buccal surface of bands on the upper first permanent molars. The appliance is assembled by first cementing the upper molar bands. Then the upper and lower portions of the appliance are inserted into the mouth, and joined laterally to each other with cold curing acrylic resin, with the patient closing lightly on the occlusal flange with the lower jaw in the normal resting position. The appliance is activated by attaching a coil spring to the 1·5 mm. wire, and thus when the appliance is held in position in the mouth by the lip muscles a distal force is effected on the upper molars, as shown in *Fig.* 1.

A number of appliances in present use utilize the oral vestibule for orthodontic purposes. Plumpers in the mandibular vestibular space are described by Salzman (1957) as a possible accessory to cervical traction. Also the propulsor extends into the upper sulcus but is rather unstable and patients tend to find it difficult to wear. The oral screen is a commonly used appliance; however, it is constructed with the teeth in centric relationship and activated in such a way that it is too unstable to be used for tooth movements other than retroclination of upper incisors. The occlusal extensions on the present appliance confer a stability to the appliance which allows the attachment of auxiliary springs. Also, the appliance can be used in conjunction with an upper fixed appliance, or for reinforcing anchorage, if sufficient clearance is allowed adjacent to the upper canine and premolar

A demonstration at the Jubilee Meeting held on May 10, 1958.

teeth, and double tubing soldered on the molar bands.

CASE REPORT

History.—A. G., female, aged 12 years. Referred by dental surgeon due to unsightly arrangement of incisors caused by loss of $\underline{1}|$ three years previously after a blow.

Diagnosis.—Angle's Class II malocclusion. Slight spacing in arches, $\underline{1}|$ missing. $3\frac{1}{2}$ mm. of space lost. Forward drift of both upper buccal segments.

Treatment Required.—Regain $3\frac{1}{2}$ mm. of space for $\underline{1}|$ by re-angulation of incisor teeth and closure of spaces. Some distal movement of buccal segments may be required.

Result.—Space regained for $\underline{1}|$. $\underline{2|1}$ uprighted (*Fig.* 2). Some upper spacing remains and from a study of the occlusion there appears that some distal movement of the upper buccal segments has occurred (*Fig.* 3).

Fig. 2.—Models showing case before treatment (June, 1957), under treatment (December, 1957), and with temporary denture inserted (January, 1958).

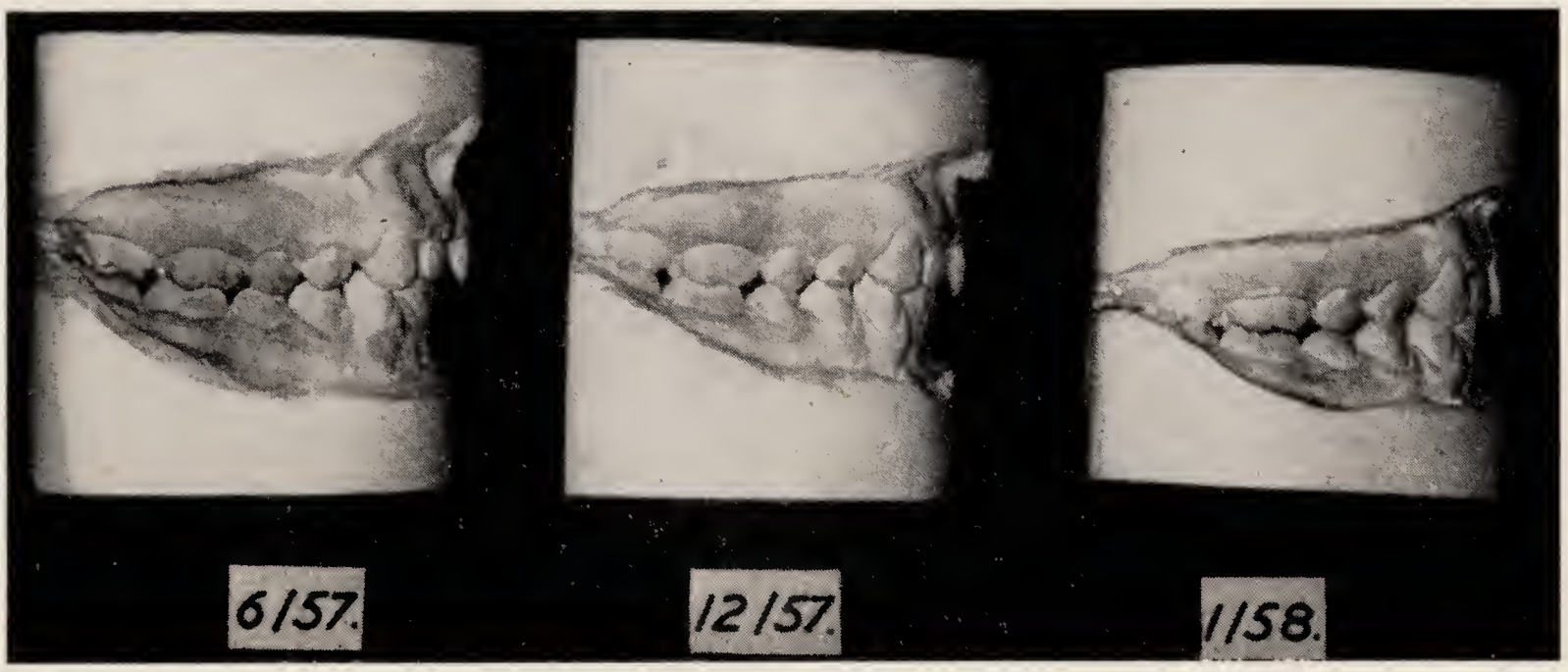

Fig. 3.—Serial models of case reported showing change in occlusion in buccal segments.

Fig. 4.—Appliance with labial auxiliary springs in addition to the coil springs for molar movement.

Comments.—The patient wore the appliance at night and occasionally in the evening. She tolerated the appliance very well and could speak with it in. The appliance is illustrated in *Fig.* 4.

CONCLUSIONS

Appliances of the design described can be used for the attachment of auxiliary springs to produce desired tooth movements. Such appliances are well tolerated by the patient and are not unsightly. A prolonged clinical trial will be necessary to decide whether the efficiency of this type of appliance is adequate

to recommend its use in routine clinical procedures.

Acknowledgements.—I should like to thank Mr. G. B. Hopkin for his advice and encouragement and Mr. G. Richardson for the construction of the demonstration models and appliances. I am grateful for the care taken in the preparation of the photographs by Mr. G. Standen.

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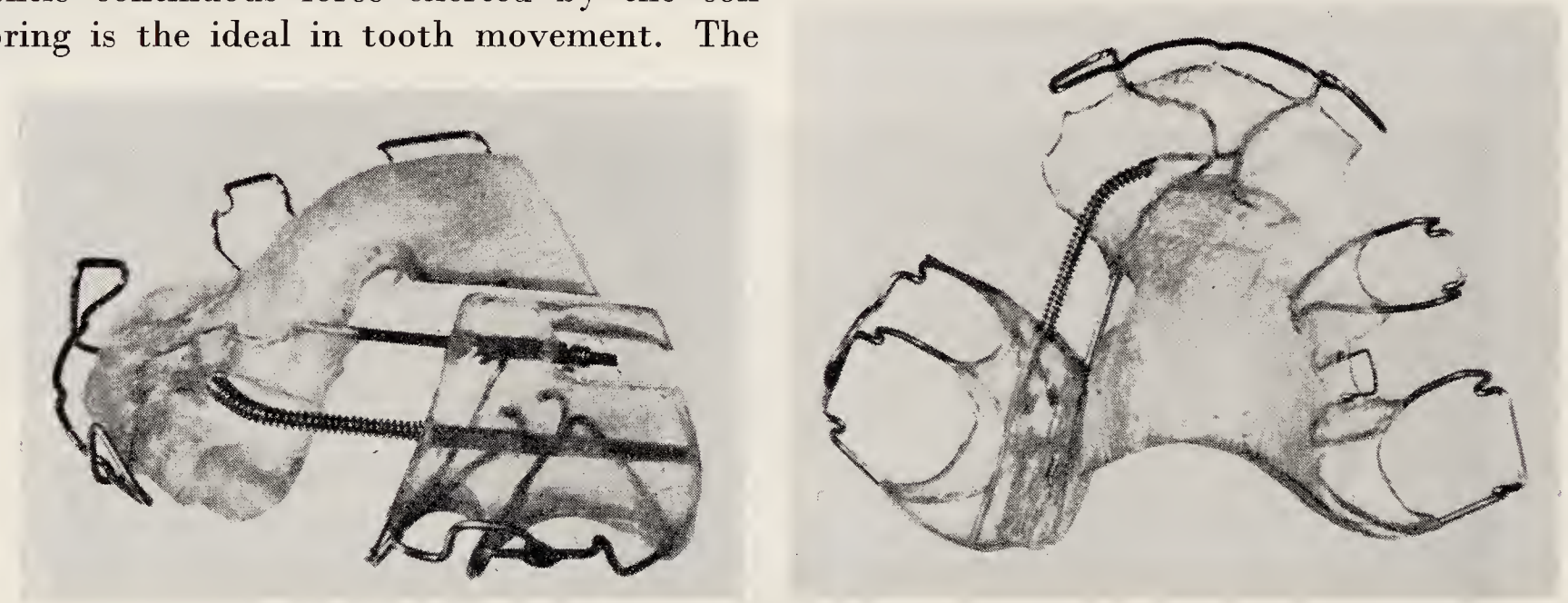
THE SLIDER: A REMOVABLE COIL SPRING APPLIANCE FOR MESIODISTAL TOOTH MOVEMENT

By **J. K. WILKIE**, B.D.S., L.D.S.

NUMEROUS appliances employing open coil springs have been described and Born (1955), in a review of their use, has stated that the gentle continuous force exerted by the coil spring is the ideal in tooth movement. The appliance now described (*Figs.* 1, 2) was developed in an attempt to overcome the relative inefficiency, in the writer's hands, of



A B

Fig. 1.—A slider constructed for distal movement of an upper molar and premolar. A, Oblique view of fitting surface. B, Vertical view of fitting surface.

A B

Fig. 2.—A similar lower appliance for distal movement of molar and deciduous molar. A, Oblique view of fitting surface. B, Vertical view of fitting surface.

A demonstration at the Jubilee Meeting held on May 10, 1958.

the screw-plate as compared with simple fixed labio-lingual coil spring appliances, and it is particularly adapted for distal movement of upper and lower molars and premolars. It differs in principle from removable coil spring appliances previously described in that the tooth or teeth being moved can also be used for retention.

Principle.—This object is achieved by using a moving section of acrylic—the slider—to provide retention for cribs and also for two short lengths of orthodontic tubing which act as parallel sleeve bearings (*Fig.* 3 D). The slider moves reciprocally on the parallel arms of a hairpin-form chassis (*Fig.* 3 A), the loop of which gains retention in the main section of the appliance.

Construction.—The component parts, specified under *Fig.* 3, are shown in order of assembly. The materials are readily available and are in common use in orthodontic practice.

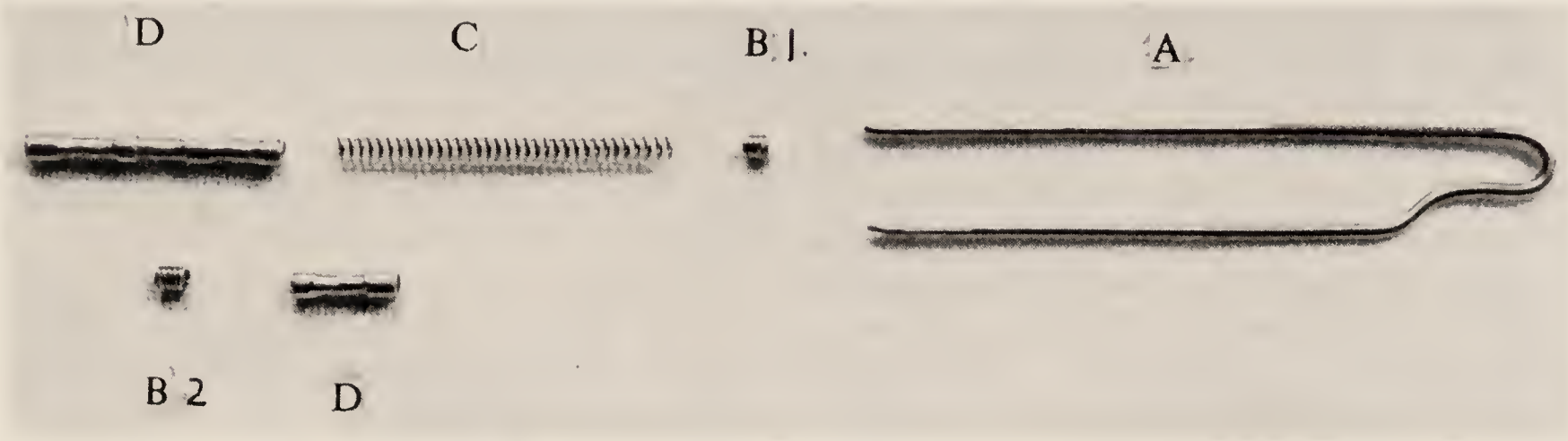
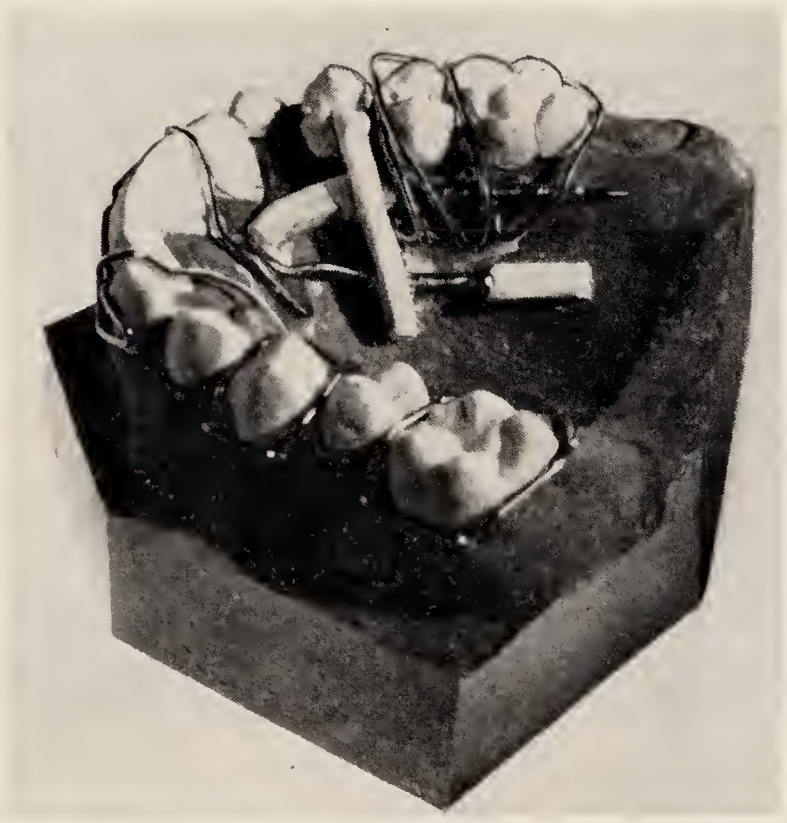


Fig. 3.—Component parts of the slider mechanism. A, The chassis—twin parallel arms of 0·9 mm. hard drawn stainless steel wire. B1, Adjuster; B2, Limit stop—friction coil fit of 0·3 mm. wire wound on 0·75 mm. wire (Johnson, 1952). C, Coil spring, 0·2 mm. wound on 0·9 mm. mandrel (Adams, 1955). D, Sleeve bearings—No. 16 gauge stainless steel hypodermic tubing, or "1·0 mm" orthodontic tubing.



A

B

Fig. 4.—Working model before waxing up, showing chassis, sleeve bearings, and method of plastering out channels and division. A, Buccal aspect; B, Occlusal aspect.

The sequence of construction is to lay down the chassis with the straight parallel sections of the arms as far apart as the depth of lingual sulcus or height of palate permits, while the retention loop and spring-carrying portions are conformed to the contour of the model. The free ends of the arms are given a short taper to aid in the addition of friction fit stops at the finishing stage. It may be useful to sketch the layout on the model initially. The sleeve bearings are of unequal length to provide space for adjustment of the distal limit stop. They are cut slightly longer than the finished

slider will require, scored for retention, and then located on the arms with their mesial ends in line with the planned division of the appliance.

Channels for the coil spring, tension adjuster, and limit stop are then plastered out on the model over the chassis arms to approximately half the thickness of the finished plate, while the division between the slider and the main section is plastered out to full thickness if immediate activation of the appliance is required. In the upper the division of the appliance parallel to the chassis arms is sawn after processing.

Fig. 4 shows two views of the same appliance before waxing up. The slight excess of tube and chassis length provides retention in the flasking plaster and prevents acrylic entering the tubes during processing. During the finishing stage this excess is removed and the arms adjusted so that the slider will move under its own weight. The appliance is assembled with the tension adjuster and coil spring mesial, and the limit stop distal to the slider. It has been found desirable to maintain the given working clearance between the chassis arms and sleeve bearings, any reduction in the internal diameter of the tubes or increase in thickness of the arms making both construction and adjustment of the appliance over-critical.

Use.—In practice it has been found advantageous to:—

1. Use a spur mesial to the tooth being moved.
2. Bend the chassis arm very slightly distal to the limit stop to prevent accidentally dismantling during cleaning.
3. Use as long a coil as space permits.
4. Warn the patient and parent that the appliance will distort if treated roughly.

Over three hundred appliances have been constructed embodying this principle and the following desirable and undesirable features have been noted in use:—

Desirable: (*a*) Efficiency in movement of teeth; (*b*) Pressures readily controllable and sustained; (*c*) Automatic adjustment if left out; (*d*) Permits of spontaneous movement of series of teeth; (*e*) Cribbing prevents rotation of two rooted premolars; (*f*) Can be set for predetermined movement; (*g*) Less bulky than screw; (*h*) Permits of adjustment for slight buccolingual movement.

Undesirable: (*a*) Instability of sliding section; (*b*) Can distort with careless usage; (*c*) Relatively complicated construction; (*d*) Requires compression on insertion.

Various modifications of the basic principle may be used in special circumstances. The mechanism may be incorporated in an appliance for activation at a later stage of treatment by division and addition of springs and stops, if all plastering out is reduced to half plate thickness during initial construction. The same technique permits independent activation of either side of an appliance designed for bilateral tooth movement; or following the loss of the upper first permanent molar a rigid arm from the main section may be used to prevent drift of the second molar while premolars are being moved distally.

Acknowledgements.—Warm thanks are due to the following: Messrs. Accles and Pollock who supplied specially selected tubes for the experimental appliances; Messrs. W. T. Johnson and P. J. Blyth for facilities to develop this appliance and permission to publish these details; Mr. F. D. Goodman and the Medical Photographic Unit of Bristol University for the illustrations.

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LOCAL APPLICATIONS OF THE "WATKIN" APPLIANCE

By **HAROLD G. WATKIN**, F.D.S., D.Orth. R.C.S. (Eng.), **PHYLLIS A. WATKIN**, D.Orth. R.C.S. (Eng.), **E. J. S. CLIFFORD**, L.D.S. (V.U. Manc.), and **JUNE P. MURRAY**, B.D.S. (L'pool)

THE chief object of this demonstration is to show the ease with which perfect control of the movement of teeth is obtained. Loops are formed along a wire with a pair of loop-forming "Watkin" pliers (*see Fig.* 6). These loops fit accurately into McKeag tubes welded to tooth bands. The adjustment of the loops can produce tooth movements in all directions, including root movement.

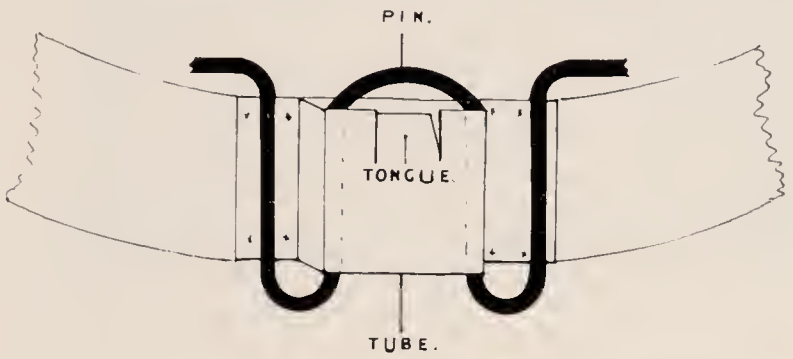

Fig. 1.

The front surface of the tubes have saw cuts in them (*Fig.* 1) which form a tongue, and when this tongue is pressed in (after the loops have been inserted) it forms a perfect lock. To unlatch the lock it is only necessary to pass the end of a small, flat plastic up the

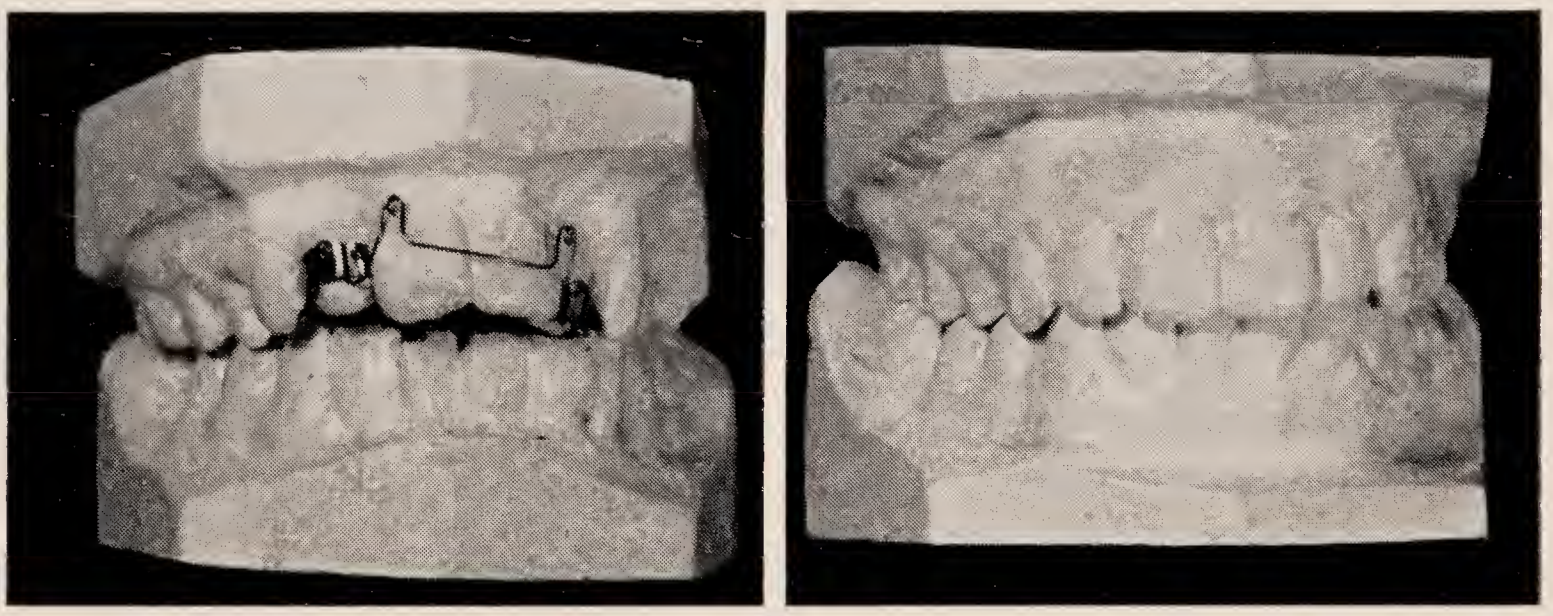

Fig. 2.

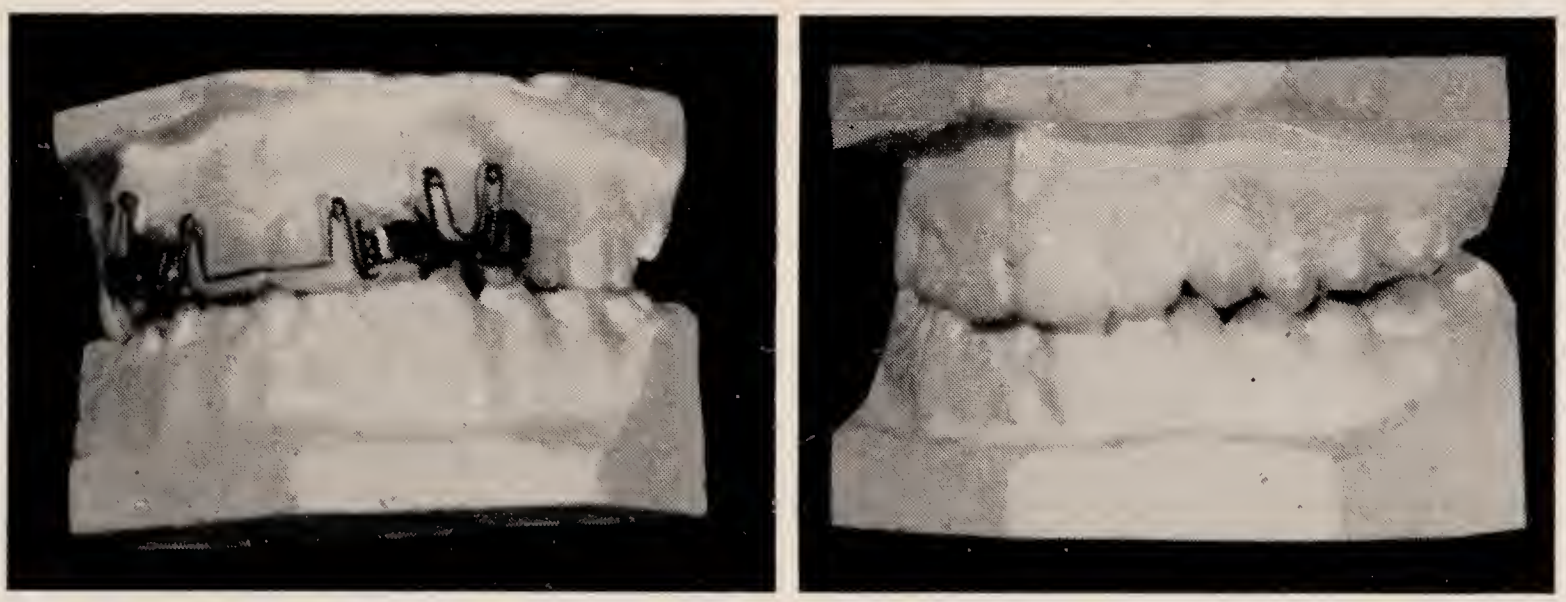

Fig. 3.

A demonstration given at the Jubilee Meeting held on May 10, 1958.

tube. This bends the "tongue" back to its original position and the loop is freed.

2|2 are too close together to allow 1|1 to be moved lingually. The appliance is activated by adjusting the loops the width of a vertical tube beyond the passive position with the horizontal wire pressing 1|1 lingually when necessary. (*Fig.* 2.)

A case of Class II, division 1 with 3|3 outside the arch and 6|6 carious: extract 6|6 and move 54|45 into normal relationship with the wire pressing 3|3 into the arch. (*Fig.* 3.)

A case where 1|1 have been lost and it is desired to move 2|2, with parallel root

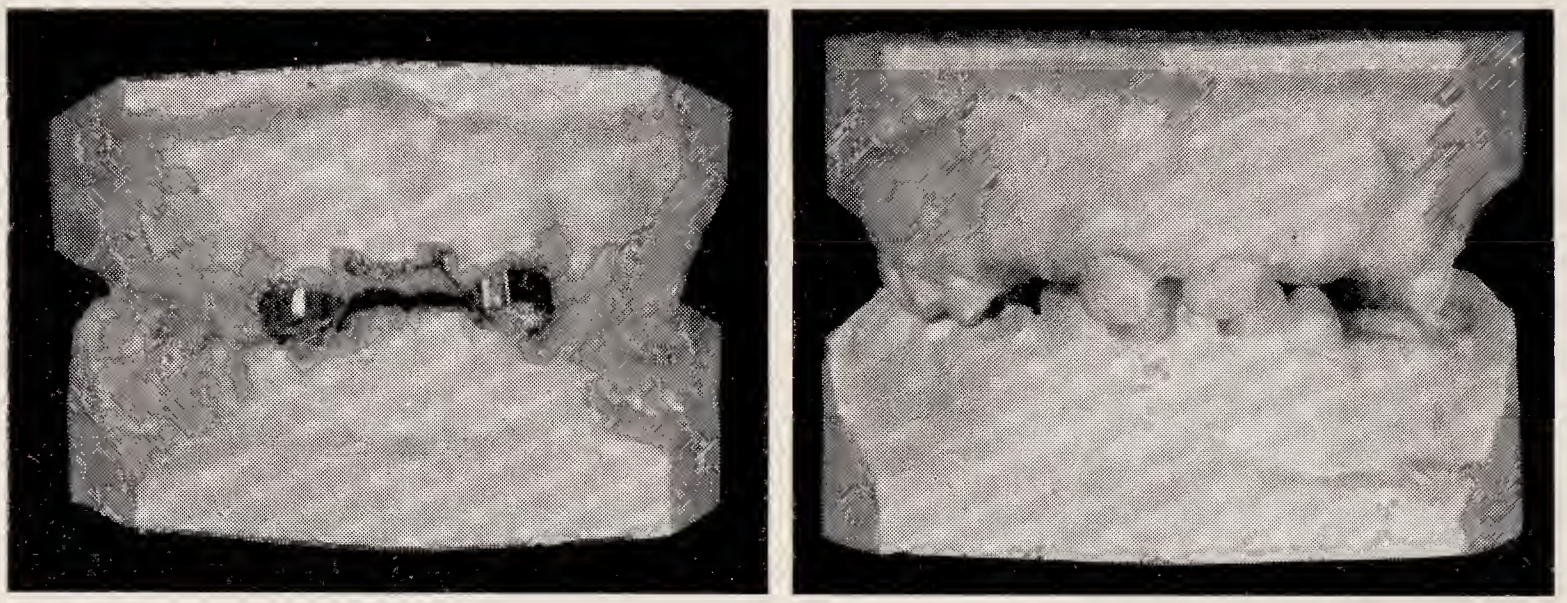

Fig. 4.

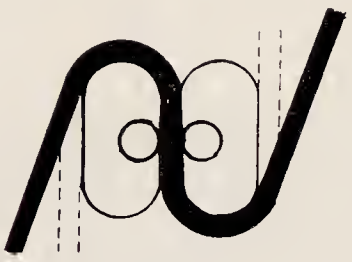

Fig. 5.

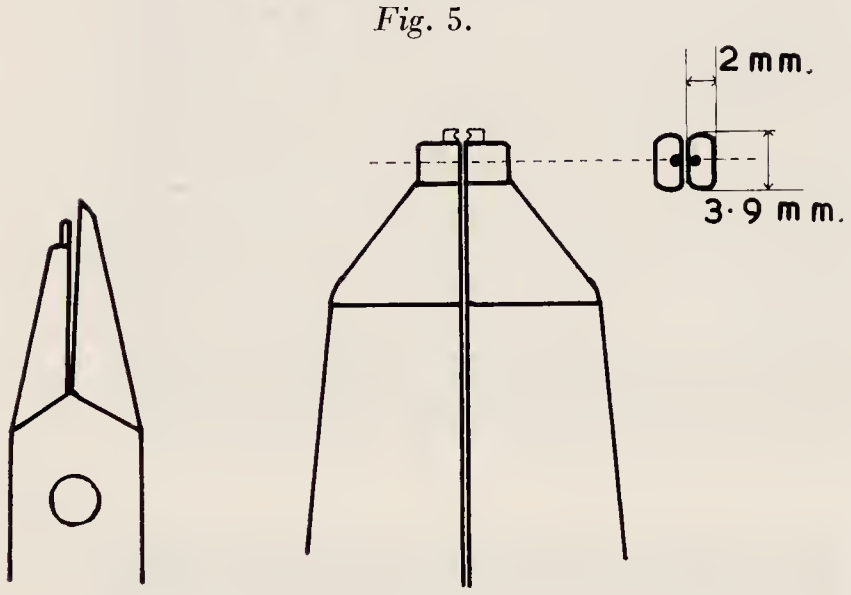

Fig. 6.

movement, close together to be crowned to replace the lost 1|1 is shown in *Fig.* 4.

The loops are formed with special loop-forming "Watkin" pliers, illustrated in use in *Fig.* 5, and the grooved tips at the ends (*Fig.* 6) are used to complete the paralleling of the sides of the loops as shown by the broken lines in *Fig.* 5.

Materials and Equipment

Wire

0·35 mm. S.S. Hard.

Band Material

Incisor	3·0×0·1 mm. S.S.
Premolar	5·0×0·15 mm. S.S.
Molar	5·0×0·15 mm. S.S.

Instruments

Spot-welder
Band-pinching pliers (Visick)
Contouring pliers
Loop-forming "Watkin" pliers
Coil-forming pliers
Band-pusher
Flat plastic instrument.

A PIN VICE TO USE IN MAKING COIL SPRINGS

By **H. E. WILSON**, L.D.S., D.D.O., D.Orth.

A No. 121 Pin Vice, 3 in. long, purchased in an ironmonger's store, was adapted to fit the dental straight hand-piece by removing the hollow shank and replacing it with a solid one 2·3 mm. in diameter. A small loop was soldered near the beaks. (*Fig.* 1.) The range of the beaks, 0·0–2·0 mm., is much greater than that usually required for core wires for orthodontic coil springs.

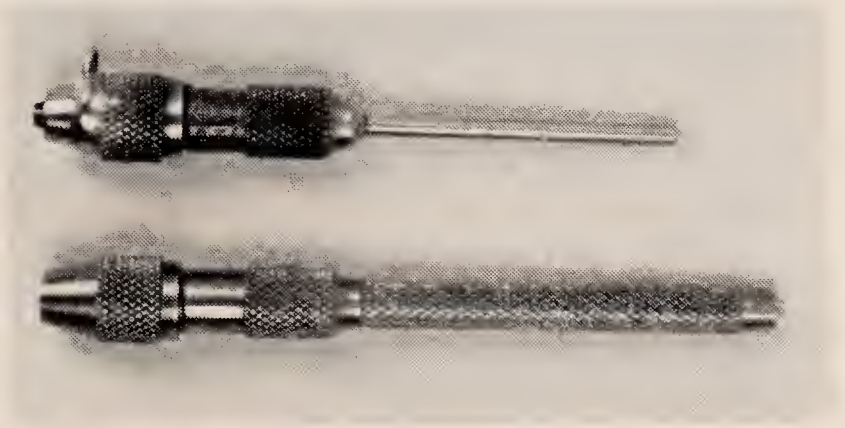

Fig. 1.—The original pin vice (*bottom*) with the modified one above.

The core wire on which the spring is to be wound is tightened in the beaks. The spring wire is threaded through the "jig" (Beresford, 1947; Adams, 1957), and tied to the loop on the vice. (*Fig.* 2.) The spring is made in the usual way with the straight hand-piece.

With this pin vice it is unnecessary to make and store core wire with attached mandrels for all diameters of coil springs.

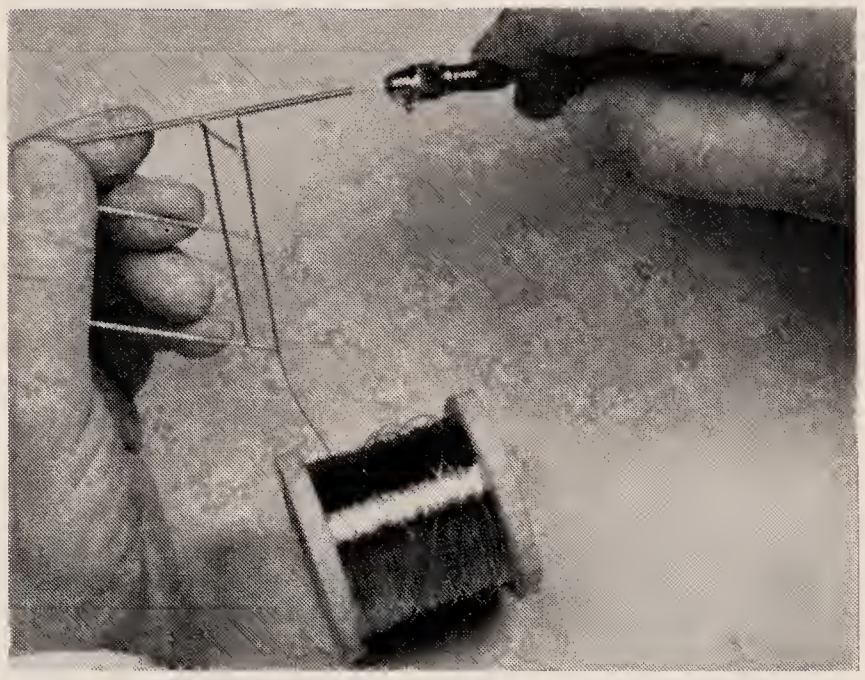

Fig. 2.—Shows the pin vice in use with the Beresford type jig.

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A SIMPLE SPRING TO ROTATE AN INCISOR

By **H. E. WILSON**, L.D.S., D.D.O., D.Orth.

THE rotation of a single incisor is at times a difficult technical problem in relation to the amount of tooth movement required. The usual methods, such as the couplet with the labial and lingual spring, or T-spring in removable appliances, or fixed multiband techniques, are not always suitable because of the position, degree of rotation, or stage in eruption of the tooth (*Fig.* 1).

The spring to be described is one which may be used instead of other methods, or at times where other techniques are not successful. It is simple, easily made, easily adapted, easily fitted, can be made of stainless steel wire up to 0·7 mm. diameter, and is therefore strong enough to be self-supporting. It consists of a simple cantilever spring (*Figs.* 2, 3), with coil (A) designed to move the tooth labially. At the point of contact there is a second coil (B), but in the reverse direction. This latter coil makes a point contact with the tooth at the part to be moved labially and it also activates the

Demonstrations given at the Jubilee Meeting held on May 10, 1958.

labial extension. The wire is continued from the second coil (B) to the labial aspect, where it makes contact with the tooth as far as possible from the coil (B). It ends in a small loop to prevent damage to the tooth and to make a surface contact, so reducing the possibility of displacement.

Fig. 1.—Shows the spring on $\underline{11}$, which, following exposure, had erupted about one-third of the crown labially and rotated. Rotation of these teeth by any other techniques would have been more difficult.

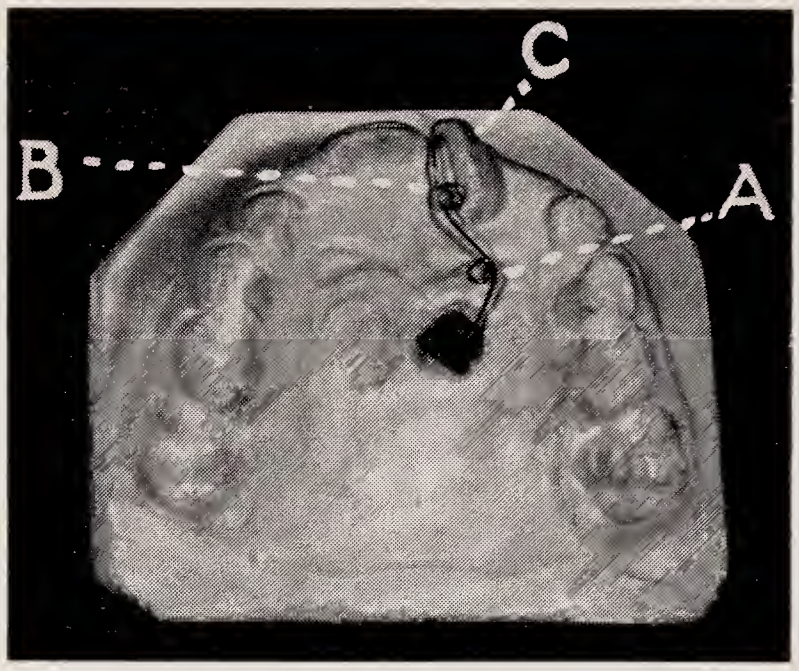


Fig. 2.—Shows the spring designed to move the tooth in the arch but rotated almost 90°. Any other technique would produce the same result but not so easily.

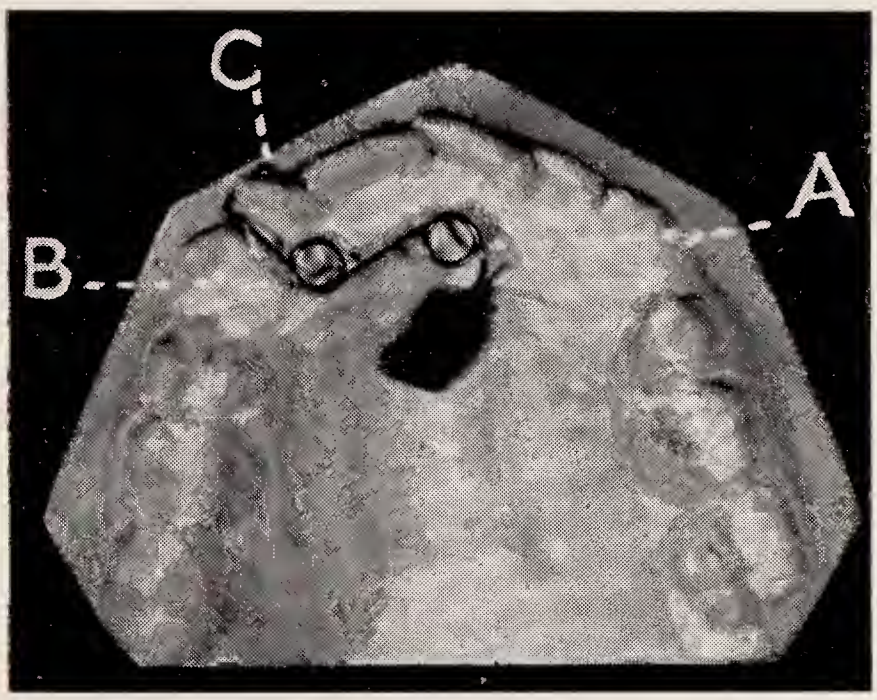


Fig. 3.—Shows the spring used on a right upper lateral rotated in a few months and which could just as easily have been achieved by any other techniques.

If the loop (A) is opened the spring will be activated and the tooth moved labially. If the loop (B) only is opened the extension will be activated and the tooth at (C) will move palatally while it will be retained at (B), thus rotating the tooth at or near (B). If both loops (A) and (B) are opened the tooth at (B) will move labially and at (C) palatally, thus rotating the tooth somewhere between these two points. The degree of rotation and displacement decides the comparative activity between the two coils. The points of contact should be on the same horizontal plane, otherwise tilting of the tooth occurs.

A LONGITUDINAL STUDY OF THE RESULTS OF PREMATURE EXTRACTION OF DECIDUOUS TEETH BETWEEN 3–4 AND 13–14 YEARS OF AGE

By **LILAH M. CLINCH**, M.A., F.D.S., D.Orth. R.C.S.
Statistical Appendix by **M. J. R. HEALY**, B.A.
Rothamsted Experimental Station

INTRODUCTION

THERE are many references in dental literature to early loss of deciduous teeth and the resultant space loss—in fact few subjects have aroused so much comment. From Fauchard, in 1742, we can find mention of the inevitability and, at the same time, the undesirability of removing these teeth before they would be shed naturally. Recently, some writers have raised doubts as to the damage to the permanent dental arches which is likely to occur. Seipel (1947, 1948), Lundström (1955 a, b), Breakspear (1951), Friel (1948, 1953), and others have shown that a lack of space at a later stage does not always follow these extractions, and yet we all see, probably daily, spaces much reduced or even closed following premature extractions. But then orthodontists see, on the whole, malformed mouths in which space loss would probably be greater and do more damage than in well-formed mouths.

Most of the work published on this subject has shown the results of premature loss without any history of the occlusion before the extractions, or of the changes which took place during the years intervening between the extractions and the final result. It is misleading to attribute imbrication in the permanent dentition to premature loss of deciduous teeth when there may always have been imbrication, but that type of mistake is likely to happen if conclusions are drawn only from the history of the extractions. From serial models it is possible to tell the type of occlusion before the extractions, the stage of development as distinct from the chronological age at which the teeth were removed, and the changes which followed. This paper is an attempt to summarize this information from 29 children who had deciduous teeth extracted owing to caries and before their natural shedding time, and whose occlusion had been studied during 11 years.

MATERIAL

The material for this study is from a series of models of children of whom impressions were

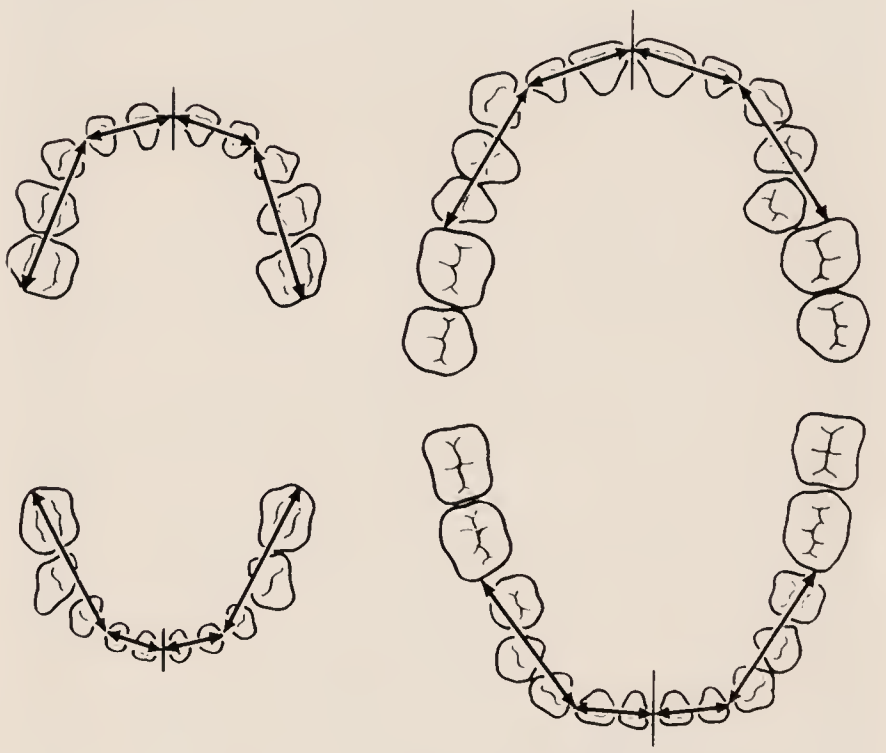


Fig. 1.—Arch measurements.

taken at yearly intervals between 3 to 4 and 13 to 14 years of age, that is, each series of models covers 11 years. They are an unselected group of children who happened to be born at the same maternity hospital, and whose mothers attended ante- and postnatal clinics in health centres in the same neighbourhood.

Details of the Series.—

1. The original number of series: 106 children.

2. The number of series at the final observation: 59.

Given at the meeting held on October 13, 1958.

3. Loss of numbers during the investigation:

a. Age when cases were lost:—

3–4 years: 7 cases
4–5 years: 12 cases
5–6 years: 9 cases
6–7 years: 5 cases
7–8 years: 4 cases
8–9 years: 3 cases
9–10 years: 4 cases
10–11 years: 2 cases
12–13 years: 1 case
Total: 47

b. Reasons for loss:—

Refused (mostly when starting school and no longer attending the postnatal clinics): 20 cases.

Moved and address unknown: 17 cases.

Illness: 7 cases.

Orthodontic treatment: 4 cases.

4. Occlusion of final series:—

Good occlusion: 31.

Normal arch relationship with subnormal arches: 15.

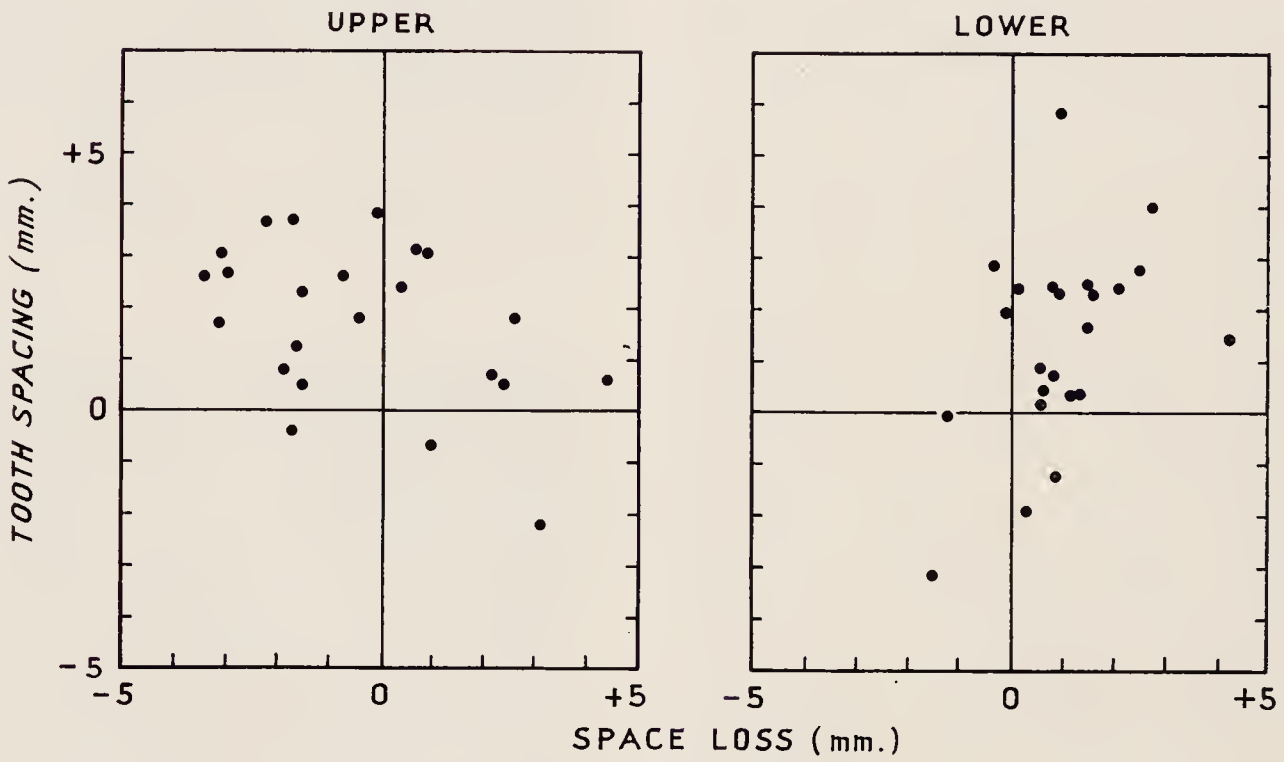


Fig. 2.—Association between total space loss and initial crowding in all the extraction cases.

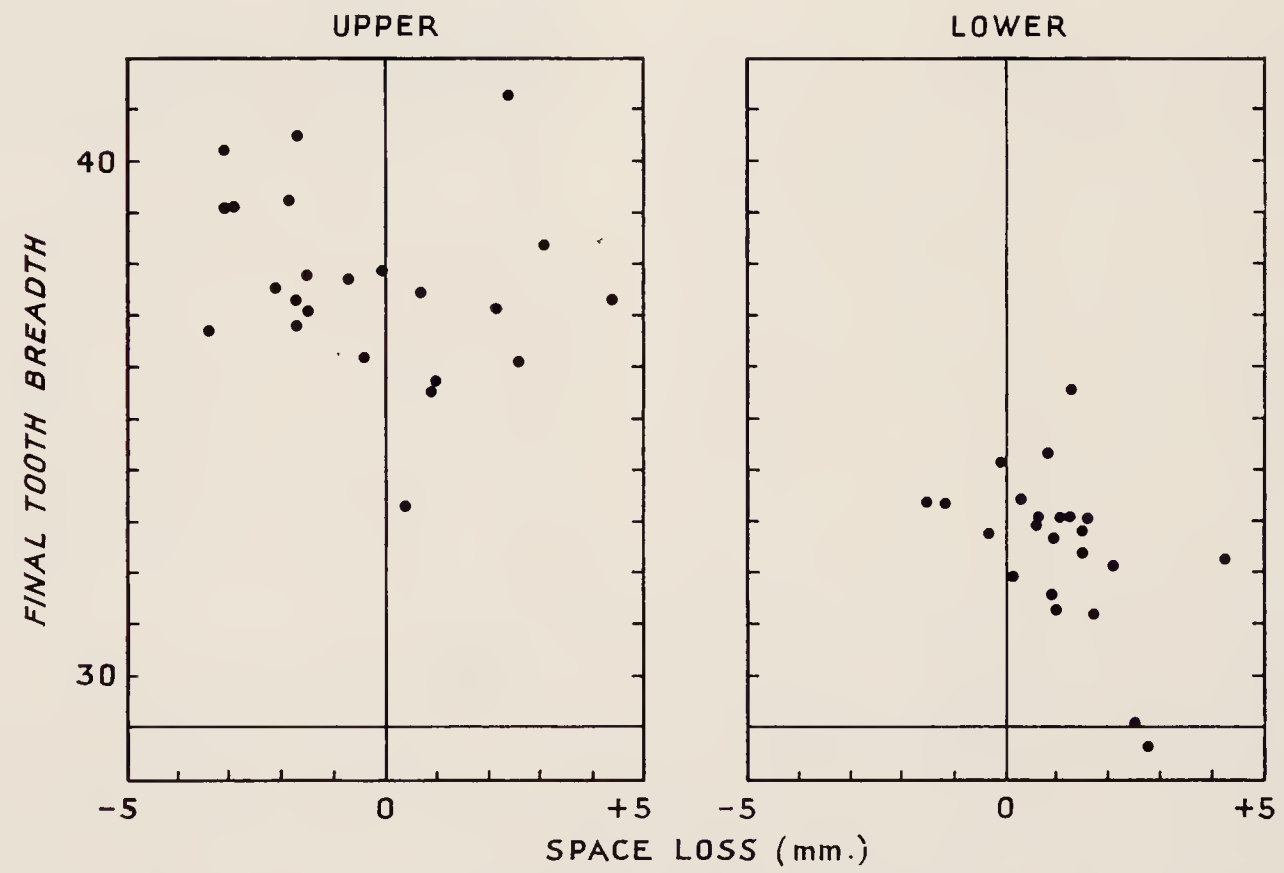


Fig. 3.—Association between total space loss and the total breadths of the 5 permanent teeth in all the extraction cases.

Postnormal occlusion of mandibular arch: 11 (including 5 with subnormal arches).

Prenormal ocelusion of mandibular areh: 2 (both with subnormal upper arches).

Only two of the final series are anxious for orthodontic treatment. This faet, and the details concerning thc reasons for the loss in numbers, are given to show that the final series remain a fair cross-section of unselected children, and does not consist of children whose parents have observed a malocelusion and have returned hoping to have it treated.

In 29 of the 59 full scrics, tecth have been extracted prematurely, and it is with thcse that this paper is concerncd, apart from 11 random non-extraction eases which havc bcen used as controls.

METHOD

Two measurements were takcn of the quadrants of each upper and eaeh lower model (*Fig.* 1):—

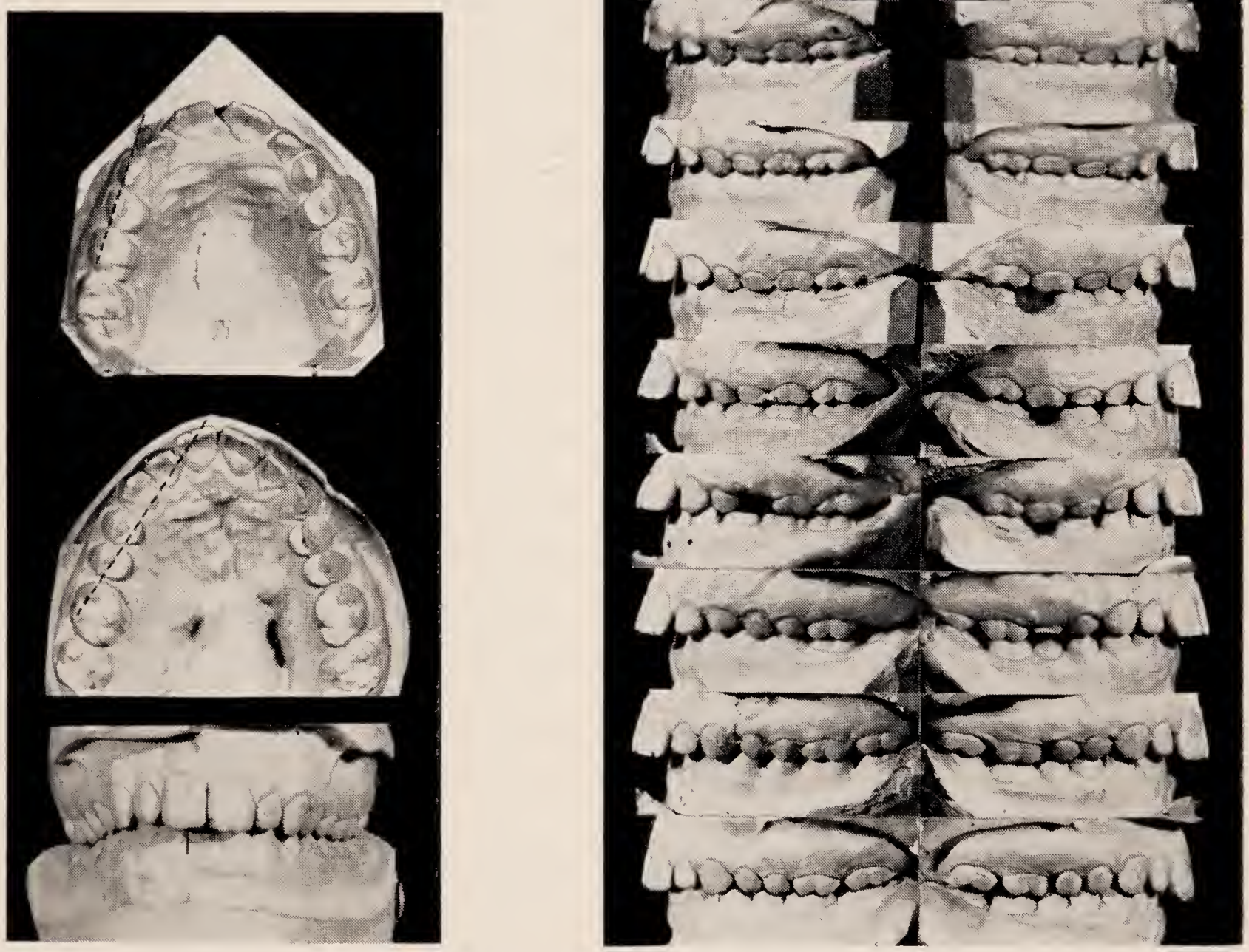
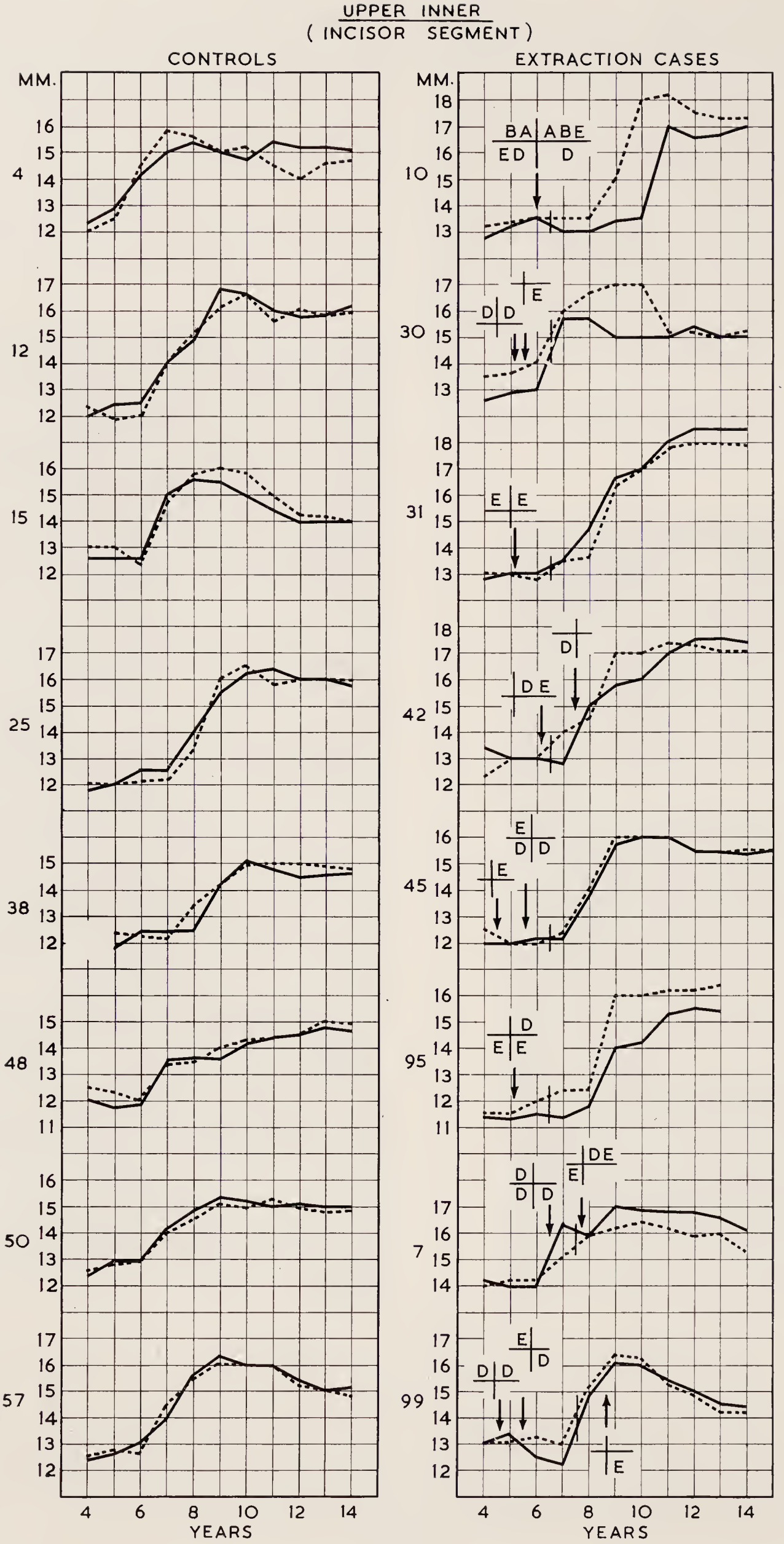


Fig. 4.—Serial models. Unilateral postnormal oeelusion. The lower right E was extraeted at 7 years 6 months. The spaee for the seeond premolar was redueed ehiefly by the drifting or tilting forward of lower first permanent molar into good anatomieal oeelusion with the upper. The forward movement anterior to the extraetion eontinued to some extent, as ean be seen by the positions of the upper E and lower D. As the lower seeond premolar erupted it moved the permanent molar distally and foreed the opposing upper molar to rotate around its mediolingual eusp, whieh was in the eentral fossa of the lower tooth. The oeelusal views show the position of the upper molar before the extraetion of the lower tooth and its rotation at 14 years. The front view of the models shows that, despite the eontinuing forward movement of the lower teeth, the right side did not move as far as the left and the eentre line in the lower has shifted towards the site of the extraetion.

On the left side the early tendeney to postnormality of the lower areh correeted itself.


UPPER INNER
(INCISOR SEGMENT)
CONTROLS
EXTRACTION CASES
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YEARS

Fig. 5.

1. From the midline to the distal contact point of the lateral incisor or, if the lateral incisor was shed or not in the line of the arch, to the mesial contact point of the canine. (The midline on the lower model was taken as the midpoint between the central incisors. In most cases the elongation of the median raphé was used as the upper midline; if this was not possible the midpoint between the centrals was used.)

2. From the distal point used in the last measurement to the distal surface of the dentition before any extractions had occurred and (*b*) the amount of space loss during the whole observation period.

2. A determination of the association between (*a*) the size of the permanent teeth and (*b*) the amount of space loss just mentioned.

This problem must, of course, be studied on all the material later, but it was interesting to see if the correlation between space loss and extractions was stronger than the correlation between space loss and tooth size in the extraction cases.

Fig. 5.—Graphs of the incisor segments of the upper arches of the controls and of cases with extraction of deciduous teeth before the eruption of the first permanent molars. The age of the eruption of the first permanent molars is indicated by a small vertical bar on each graph of the extraction cases. The teeth extracted and the ages when the extractions occurred are indicated by arrows. Right side—continuous line. Left side—dotted line. This measurement tends to increase in the extraction cases due to tilting distally of crowns as roots move forward with bone.

Two control cases are of interest:—

Case 12: There is a *large* increase n the incisor segments. This child sucked 3 fingers all through the period under investigation.

Case 25: There is a *large* increase in the incisor segments. At 4 years there was rotation of upper deciduous lateral incisors and very little spacing. Despite large teeth there is no imbrication of the incisors at 14 years. An exception to the general rule.

second deciduous molar as near to the contact point with the first permanent molar when it erupted as could be judged, or to the mesial contact point of the first permanent molar if the second deciduous molar had been extracted or shed.

No quadrants were included in which permanent teeth had been extracted, but this only applied to two quadrants.

In addition to the arch measurements, the tooth-breadths of the first and last models were also measured, as the problem of the variation in final loss of space might be connected with a primary tendency to crowding due to a discrepancy between tooth size and arch size (as shown by Lundström), apart from the result of the extraction. This was studied in two ways:—

1. A determination of the association between (*a*) relative spacing in the deciduous

The statistical analysis of these measurements is appended. Dealing with the clinical examination of each series of models, notes were made on the following points:—

1. The occlusion of the first models at 3–4 years of age, with special reference to spacing in the arches and the alinement of the teeth at 13–14 years.

2. The tooth or teeth extracted.

3. The time of the extraction, chronological age, and stage of the dentition and the age at which the first permanent molars erupted.

4. Unilateral or bilateral extractions and any alteration in the midline.

5. The effect of cuspal interlock if the extractions were in opposing quadrants of the arches or in one quadrant only.

6. The relative amount of space loss in upper and lower arches and whether the reduction was due to a mesial drift of the teeth

distal to the break in the arch or a lack of forward growth mesial to the break in the arch.

7. The occlusion of the final models, with special reference to areas of imbrication (if present), incisor, canine, or premolar, and the order of eruption of the teeth.

These notes were then co-ordinated with the statistical findings:—

1. Spacing in the deciduous dentition seems

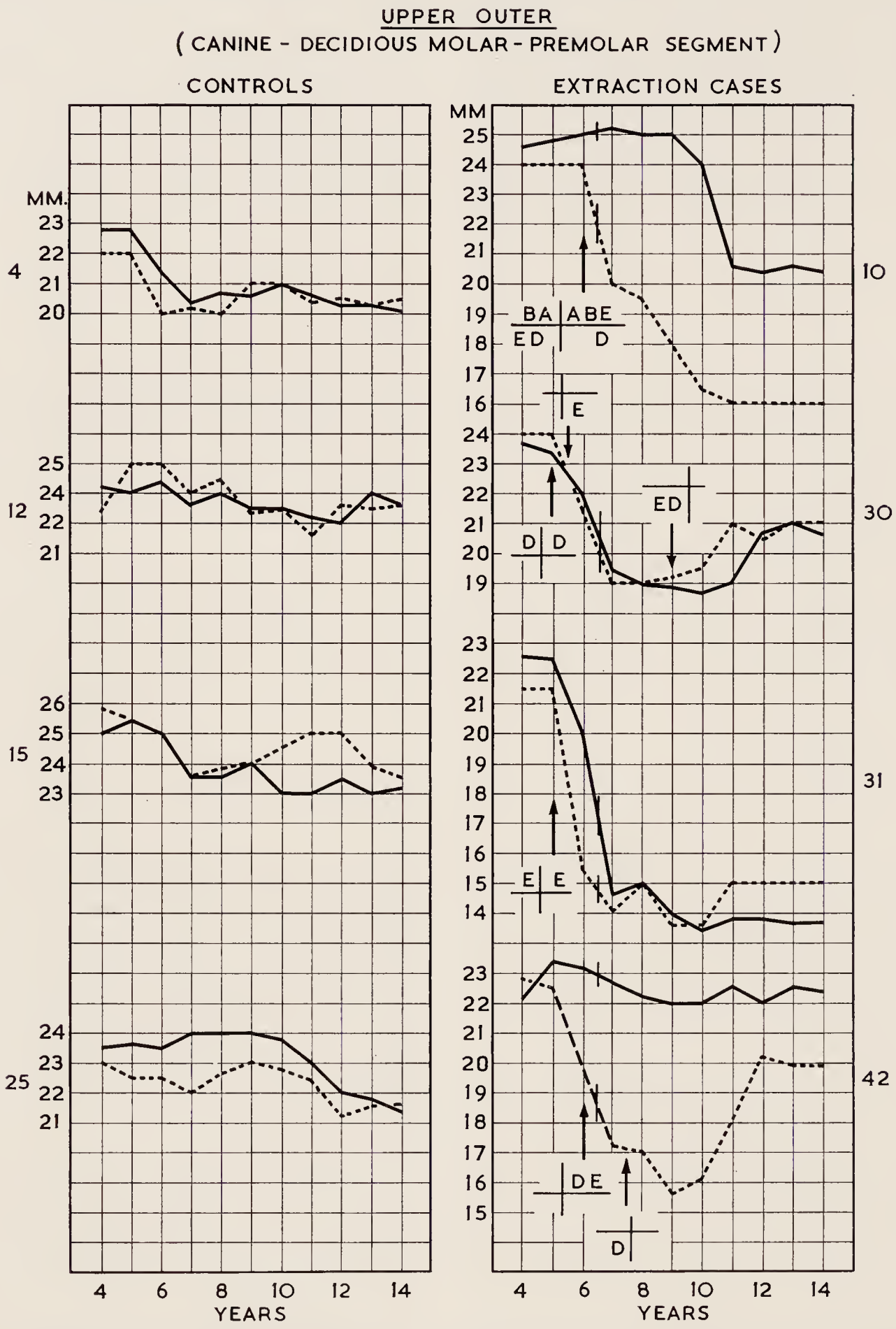


Fig. 6.—Graphs of canine deciduous molar or premolar segments of the upper arches ot the control and early extraction cases. Details as before.

Two control cases are of interest:—

Case 12: Shows a slight *increase* on the left side in this segment. There is a space of 1 mm. between the lateral incisor and canine at 14 years (this is the finger-sucker whose incisor segment was also abnormally large).

Case 57: There is large decrease on the right side in the outer segment (similar to the effect of extraction). Here the 6 impacted on E and knocked it out. At 14 years the space for $\underline{5|}$ is closed.

to have a connexion with the degree of space loss after extractions, but the connexion differs in the two arches. It is very apparent in the upper arch and less so in the lower. is less surplus space after the shedding of the deciduous molars in the upper than in the lower. This explains to some extent the findings in the measurements of the extraction

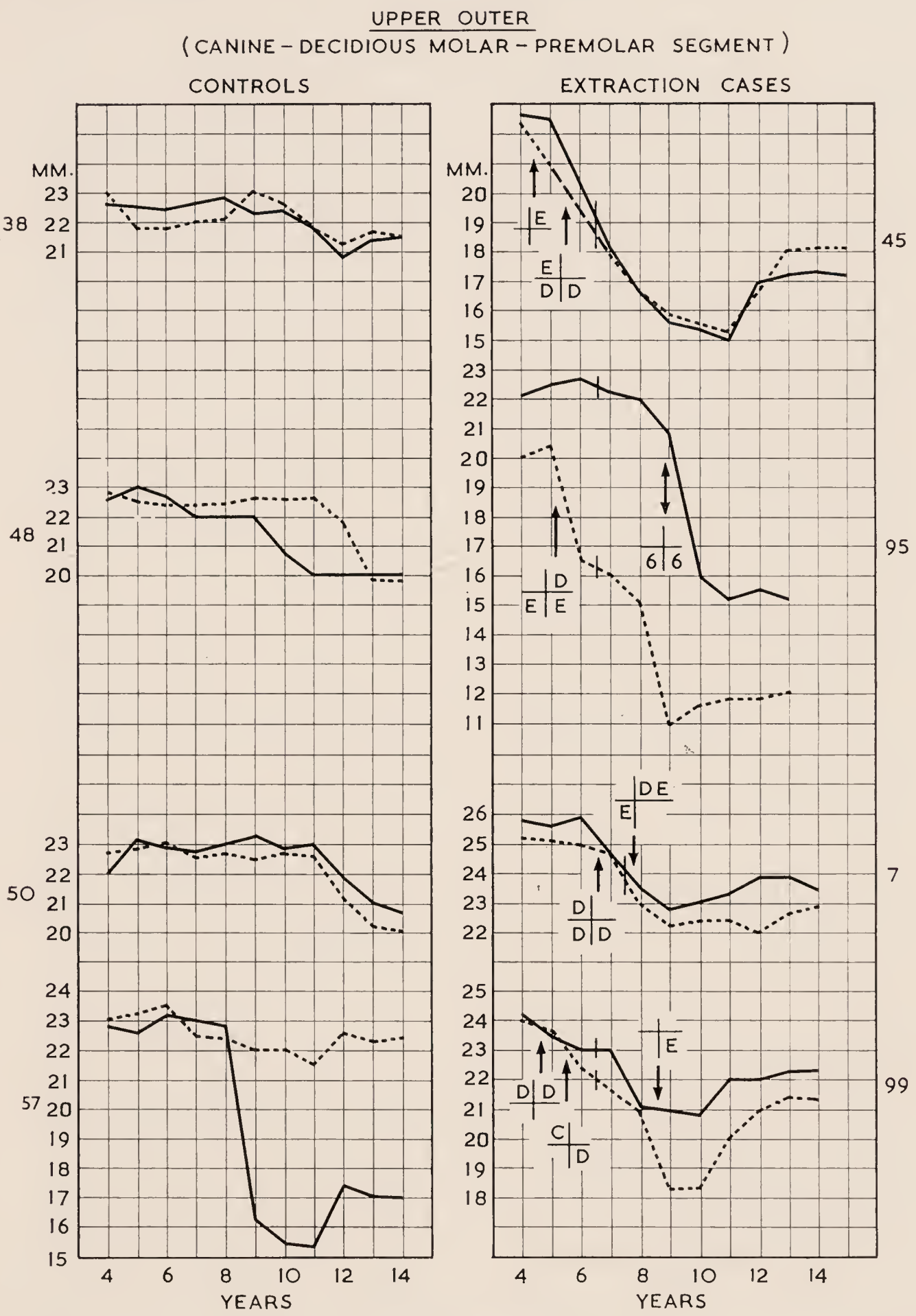


Fig. 6 (continued).

There are two factors which must be borne in mind when comparing the behaviour of the upper with the lower arch. First, the space loss after extraction is always greater in the upper than in the lower, and secondly, there cases that there is a significant correlation between space loss (the decrease from the first to the last models) and spacing (the difference between arch measurement and total tooth measurement in the first models), but it is a

negative correlation in the upper and a positive in the lower (*Fig.* 2). The difference in the two arches needs more elucidation and it is hoped that it may be possible to explain it more clearly after the correlations in the non-extraction cases have been worked out.

This also applies to tooth size and space loss, as a significant correlation was found between the total breadth of the 5 lower permanent teeth in each quadrant and the space loss, and in the upper this correlation was not significant (*Fig.* 3).

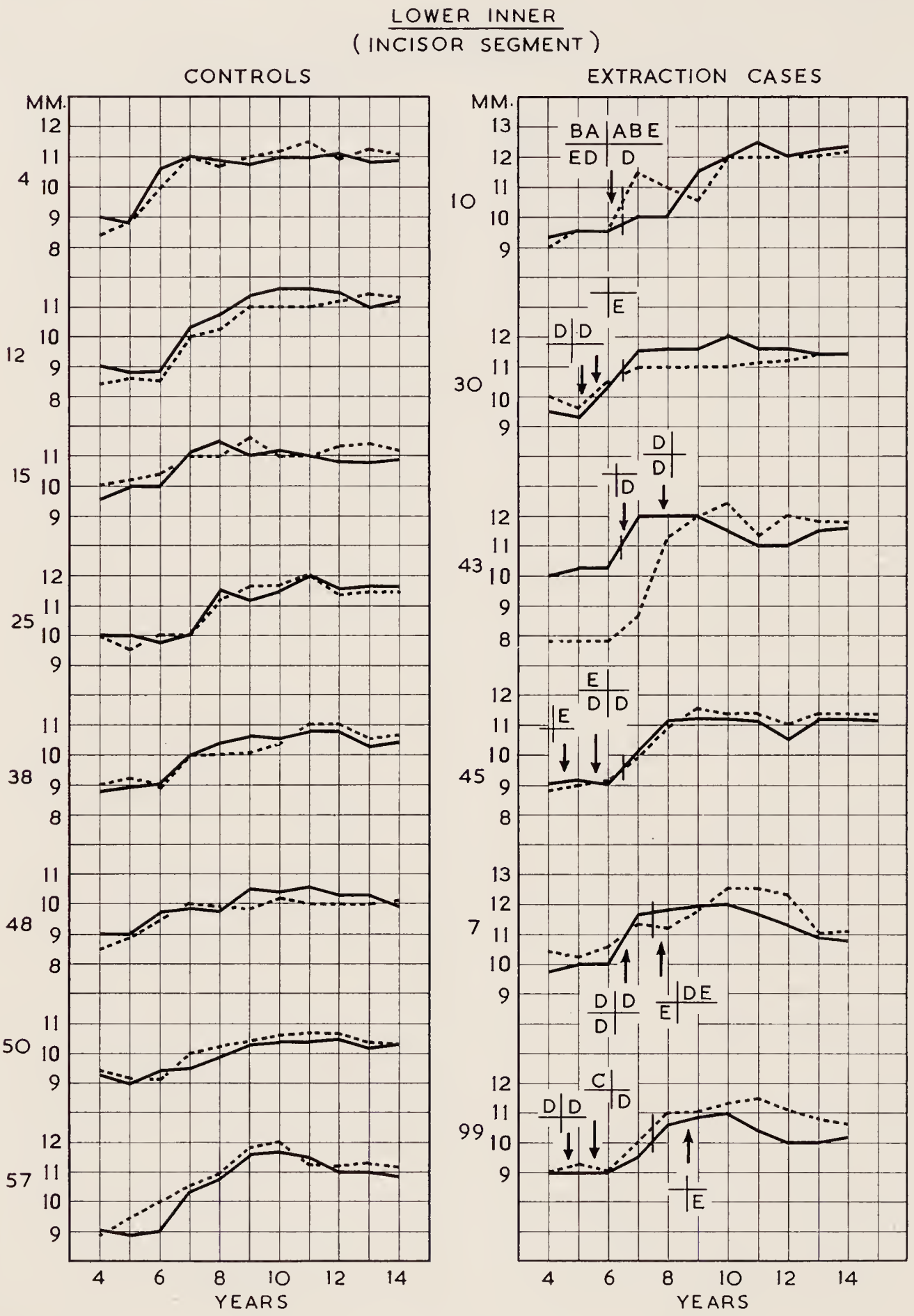


Fig. 7.—Graphs of the incisor segments of the lower arches of the controls and early extraction cases. Details as before. As in the uppers this measurement tends to increase in the extraction cases but to a lesser extent.

In children with well-developed arches the migration was usually small and temporary, and in one case there was not even a temporary reduction in space. Of the 29 cases, 10 showed

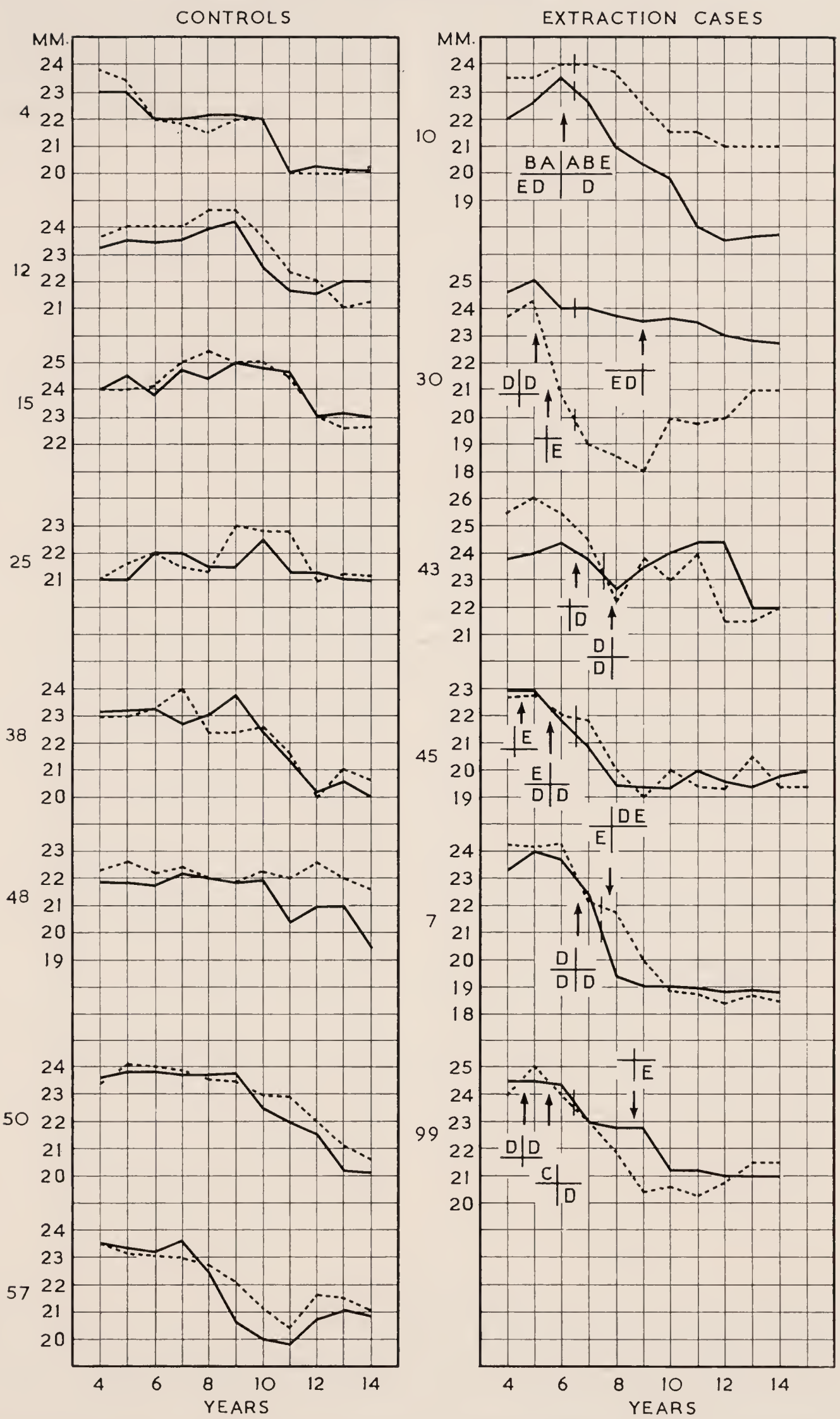


Fig. 8.—Graphs of the canine deciduous molar or premolar segments of the lower arches of the controls and early extraction cases. Details as before. Space loss less than in the upper.

Note on one control case:—

Case 25: There is no decrease in the outer segment. At 4 years the lower canines were buccal to the line of the arch and measurement from B to E was therefore less than the tooth breadths of CDE on each side.

As in the upper arch there has been an unusual degree of jaw growth, and at 14 there is good alinement of the canines and premolars.

no imbrication in the final models (some had spacing) after the full eruption of the premolars and second molars, despite the extraction of both first and second deciduous molars in all quadrants of both arches between $6\frac{1}{2}$ and $8\frac{1}{2}$ years; all these cases had good spacing in the first models. On the other hand the greatest permanent damage was done in the less well-developed arches in which there was no spacing at 3–4 years. The lack of space tended to increase in subnormal arches.

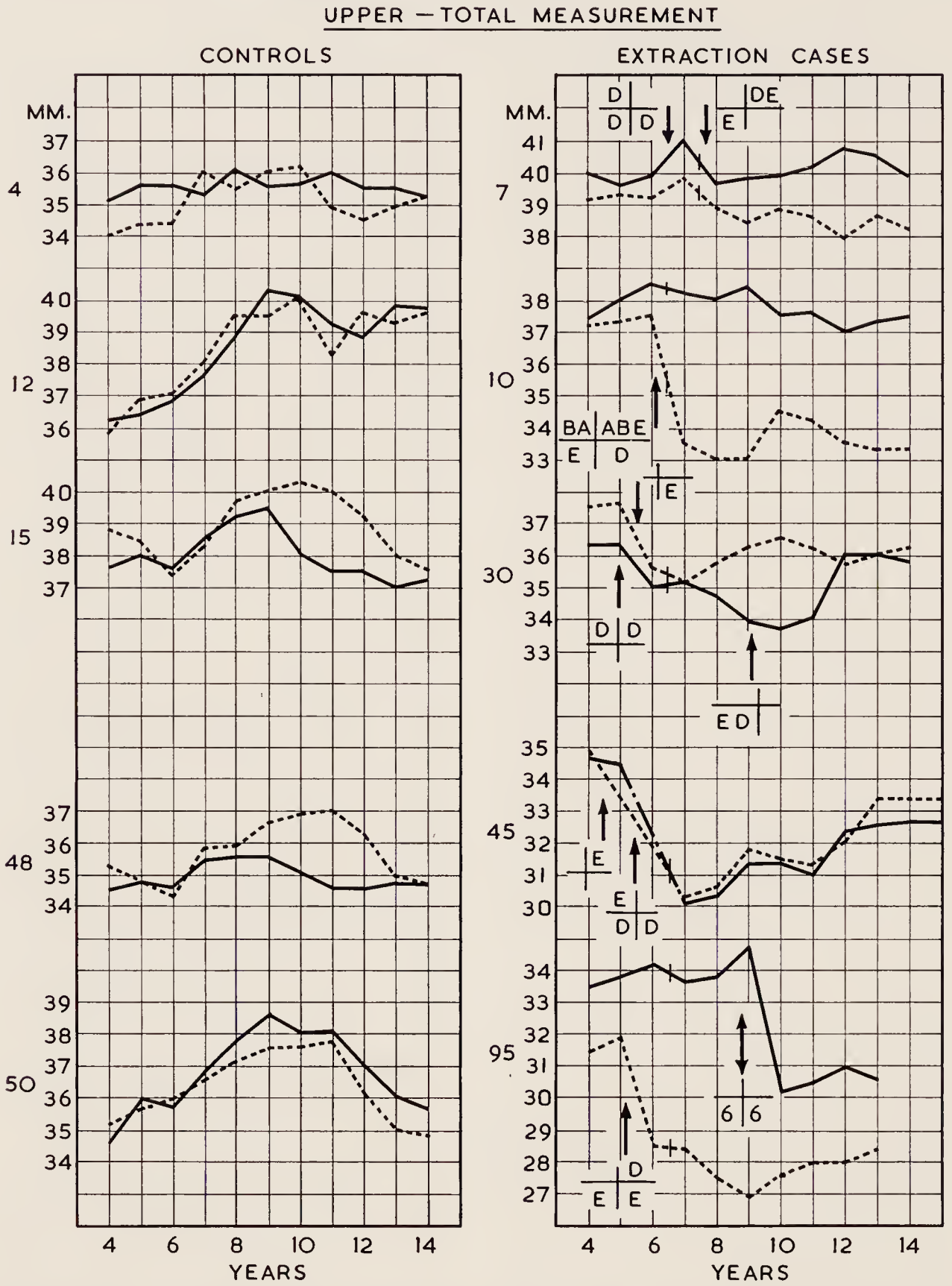


Fig. 9.—Graphs of total measurements of upper arch quadrants of controls and early extraction cases. Areas of imbrication in upper arches in extraction cases at 14 years:—

Case 7: Upper left incisor and canine spaces reduced.

Case 10: Upper left second premolar in palate and space nearly closed. Right canine space reduced.

Case 30: Upper right canine space reduced and left canine space slightly reduced.

Case 45: Upper canine and first premolar spaces reduced on both sides.

Case 95: Prenormal mandible. Upper canine spaces closed and incisors imbricated.

Case 31: Prenormal mandible. Upper second premolar spaces reduced.

Case 42: Upper left canine space reduced. On the right the combined measurement of upper CDE was slightly less than that of 345. Although there was no extraction in the lower arch there was marked imbrication of the incisors at 14 years.

Case 99: Upper premolar space reduced.

2. The extraction of the second deciduous molar produced considerably more space loss than the extraction of the first deciduous molar. Only one case had incisors extracted and this showed no permanent space loss.

mandible. The other had a lower first deciduous molar extracted at $5\frac{1}{2}$ years; this case had good spacing at 4 years and at 14 years there was spacing between the upper canines and first premolars on both sides and in the lower

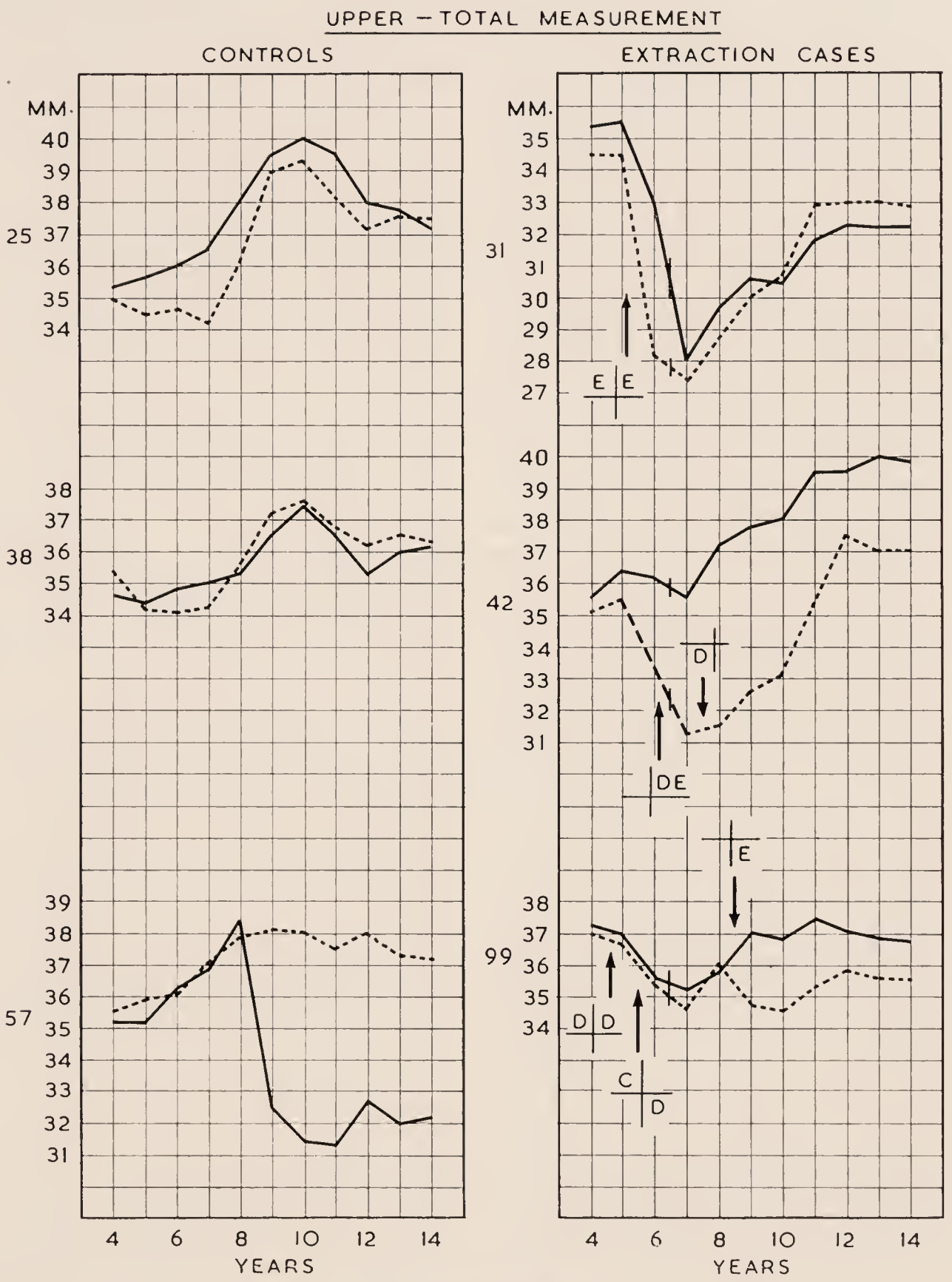


Fig. 9 (continued).

3. If there were extractions either of first or second deciduous molars before the eruption of the first permanent molars, the loss of space was never fully recovered in the upper arch. In the lower, 2 out of 7 arches showed no imbrication even after very early extractions, but 1 of these was a case of prenormal

on the non-extraction side. On the extraction side although there was no imbrication there was no spacing; so it would appear that there was a loss of space. The permanent space loss after extractions before the eruption of the first permanent molars in this material is contrary to Seipel's findings of no loss of

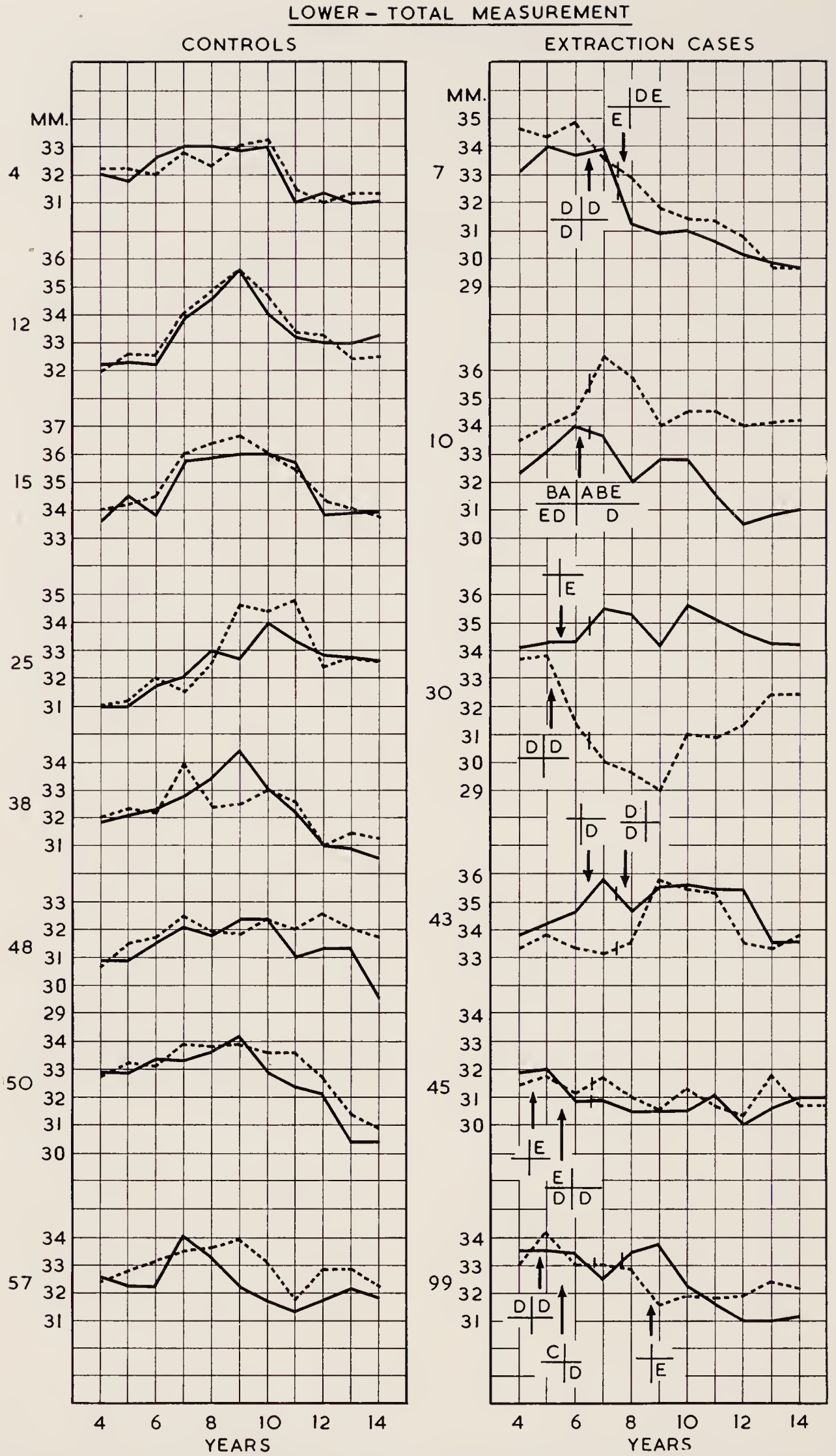


Fig. 10.—Graphs of total measurements of lower arch quadrants of controls and early extraction cases. Areas of imbrication in lower arches in extraction cases at 14 years:—

Case 7: Lower left canine and first premolar, and right second premolar spaces reduced.

Case 10: Lower left canine and lateral incisor space reduced.

Case 30: Lower left canine and lateral incisor space reduced.

Case 43: No imbrication but there is spacing at 14 years in all quadrants except the lower left where D was extracted 12 months before the eruption of the first permanent molar.

Case 45: Imbrication of lower incisors.

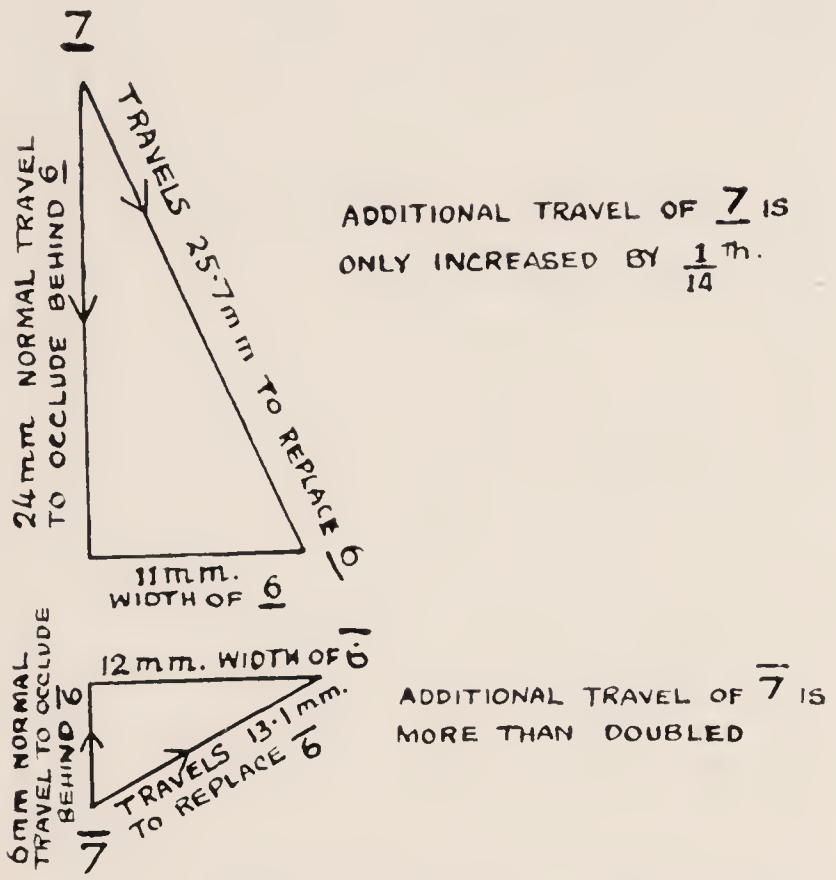
Case 99: Lower right first premolar space reduced, and left second premolar space reduced. Also imbrication of incisors.

spaee in 25 per eent of 50 ehildren examined who had deeiduous molars extraeted at 3–5 years. He eompared the right and left sides in eases of unilateral extraetions.

The result of extractions at later stages of areh development were so varied that no generalizations eould be made.

this it would seem that a eomparison between spaee loss in the lower areh on the right and left side in unilateral extraetion eases may not be very aeeurate and eould be misleading.

5. Cuspal interloek seemed to reduee the space loss in some eases and not in others. One ease of postnormal mandibular areh


7
24 mm. NORMAL TRAVEL TO OCCLUDE BEHIND 6
TRAVELS 25·7 mm TO REPLACE 6
11 mm. WIDTH OF 6
ADDITIONAL TRAVEL OF 7 IS ONLY INCREASED BY 1/14 th.
6
12 mm. WIDTH OF 6
6 mm NORMAL TRAVEL TO OCCLUDE BEHIND 6
TRAVELS 13·1 mm. TO REPLACE 6
7
ADDITIONAL TRAVEL OF 7 IS MORE THAN DOUBLED

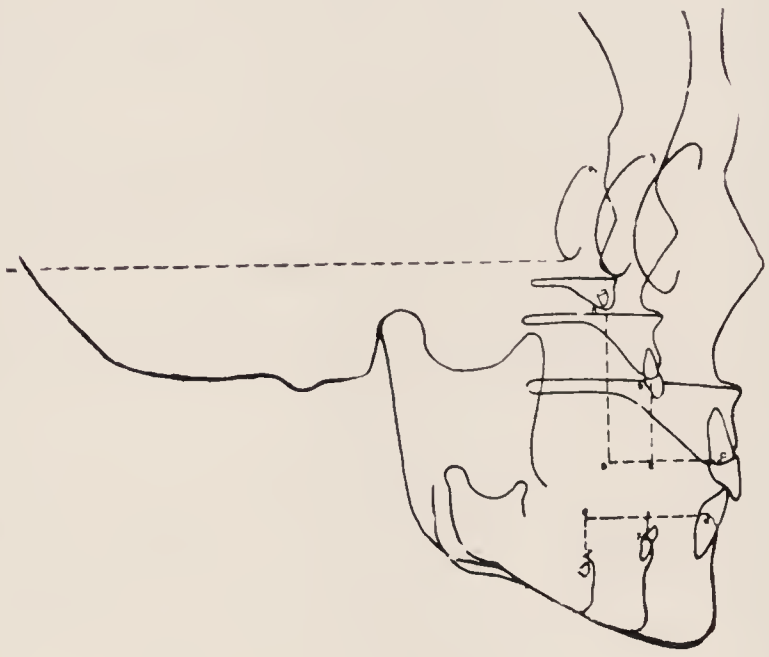


Fig. 11.—Friel. Increased distance of movement in upper arch less than in lower after extraction of first permanent molars.

4. Unilateral extraetions had varying effeets. Twelve of my series had unilateral extraetions in either the upper or lower areh. In these, 7 showed no alteration in the midline. One showed a temporary shift towards the site of the extraetion of the upper midline as eompared to the lower after the extraetion of an upper first deeiduous molar, but the midline was eorreet at 14 years. Two showed a temporary shift of the lower midline as eompared to the upper after the extraetion (of a lower first deeidous molar in 1 ease and lower first and seeond deeiduous molars in the other), but again the midline was eorreet at 14 years. Two showed a permanent shift of the lower midline within a year of the extraetions; of these 1 had a lower seeond deeiduous molar extraeted and the shift was 3·8 mm. towards the site of the extraetion at 14 years; the other lost a lower first deeiduous molar, and the shift was 3·5 mm. at 14 years. From relationship, in whieh a lower seeond deeiduous molar was extraeted, showed the mediolingual rotation of the upper first permanent molar oeeurring as the lower first permanent molar whieh had drifted mesially was moved baek by the eruption of the seeond premolar (*Fig.* 4). It demonstrates how a molar ean rotate at a late stage in an unbroken areh. This ease showed, too, the permanent shift of the lower midline, the spaee for the premolar being obtained by the foreing or tilting distally of the molar and the laek of forward movement anterior to the extraetion was not eorreeted.

The effeet of extraetions in opposing quadrants, apart from the oeelusal eusp relations, is diffieult to assess. In one ease the distal surfaee of the slightly overerupted upper seeond deeiduous molar seemed to be keeping the lower first permanent molar from moving mesially after the loss of the lower deeiduous

molars, as the extractions were done soon after the eruption of the first permanent molars and yet there was no reduction in space in this quadrant: in the same case in the upper arch after the loss of second deciduous molar the second premolar space closed completely. In another case the lower first deciduous molar seemed to prevent the mesial shift of the upper second deciduous and first permanent molars on one side but not on the other.

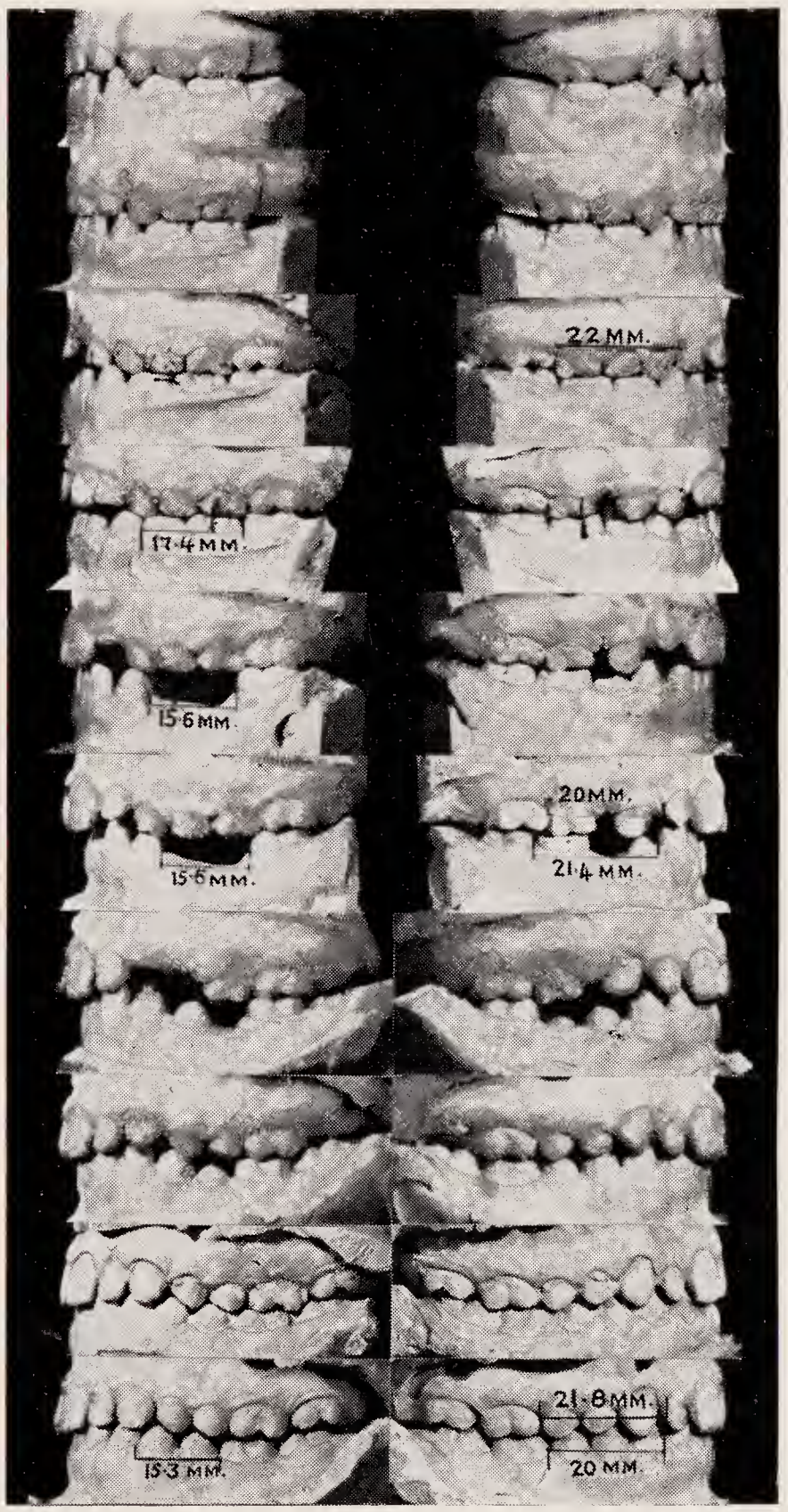


Fig. 12.—Serial models. The upper right first deciduous molar extracted at 6 years 3 months. At 6 years EDC| measured 22·0 mm.; at 9 years 6–2| measured 20·0 mm.; at 14 years 543| measured 21·8 mm.

The lower right first deciduous molar extracted at 8 years 6 months, but a reduction in space is possible as 543| measure 20 mm.

The lower left first and second deciduous molars extracted at 7 years 6 months. The premolar space is reduced 2 mm. in the first year after the extraction and then changes little; further reduction is possible as the premolars measure 15·3 mm. in the final models and this enables the second molars to occlude correctly.

6. The relative amount of space loss in the upper and lower arches can be seen more clearly in the graphs made from the arch measurements. (*Figs.* 5–10.) It is obvious that the reduction in space, both temporary and permanent, is much greater in the upper than in the lower. In the upper arch more space appears to be lost by the mesial migration of the teeth posterior to the site of the extraction, while in the lower there appears to be a greater tendency to space loss due to lack of forward growth of the teeth anterior to the extraction. The greater tendency to shift of the lower midline in unilateral extraction cases would demonstrate this. Friel (*Fig.* 11) has shown the reason why mesial migration of the second permanent molar after the loss of the first permanent molar is so much greater in the upper than in the lower. By superimposing the mandible at birth on the adult mandible, with the anterior border of its ramus in the vertical plane of the corresponding adult surface and with its lower border alined on the lower border of the adult mandible, he demonstrated that, although the forward growth of the upper and lower jaws is almost the same, the vertical growth is much greater in the upper jaw than in the lower. Hence only a slight change in the angle of descent and a slight increase in the distance of movement (an addition of 1/14) is necessary to enable the upper second molar to move into the first molar space; in the lower, however, the second molar has to make a much greater angle and hence a much greater increase in the distance of movement (which is more than doubled) to replace the first molar. In the same way, if the second deciduous molar is extracted before the eruption of the first permanent molar in the upper arch, the first permanent molar may erupt in contact with the first deciduous molar by only a slight additional movement, whereas in the lower arch the additional movement of the first

permanent molar would be so much greater that there is never such a marked loss of space.

7. The order of eruption of the teeth had some effect on determining the area of imbrication. Naturally, where there was a reduction in space the canine was usually crowded out of the arch if it erupted after the premolars, but if the upper second deciduous molar was extracted before the eruption of the first permanent molar the space for the second premolar was invariably reduced rather than the canine space. The eruption of the second molars before the premolars did seem to have some effect on the space loss, but it happened rarely. In only 13 out of 116 quadrants the second molar preceded the premolars and in 10 of these (6 lower and 4 upper) there was a reduction in premolar space. It has been stated that there is a certain tolerance for decrease of space values in the premolar region, due to the lesser dimensions of the permanent teeth. But it should be remembered that if the second permanent molars are to occlude correctly, this extra space in the premolar region should be used up partly to accommodate the permanent canine and partly to allow a greater mesial migration of the lower first permanent molar than the upper (*Fig.* 12). Friel shows this clearly as a stage in the development of occlusion, and if this alteration in the molar relationship is prevented by premolars erupting into a reduced space, then the occlusion of the teeth distal to the space loss will be incorrect.

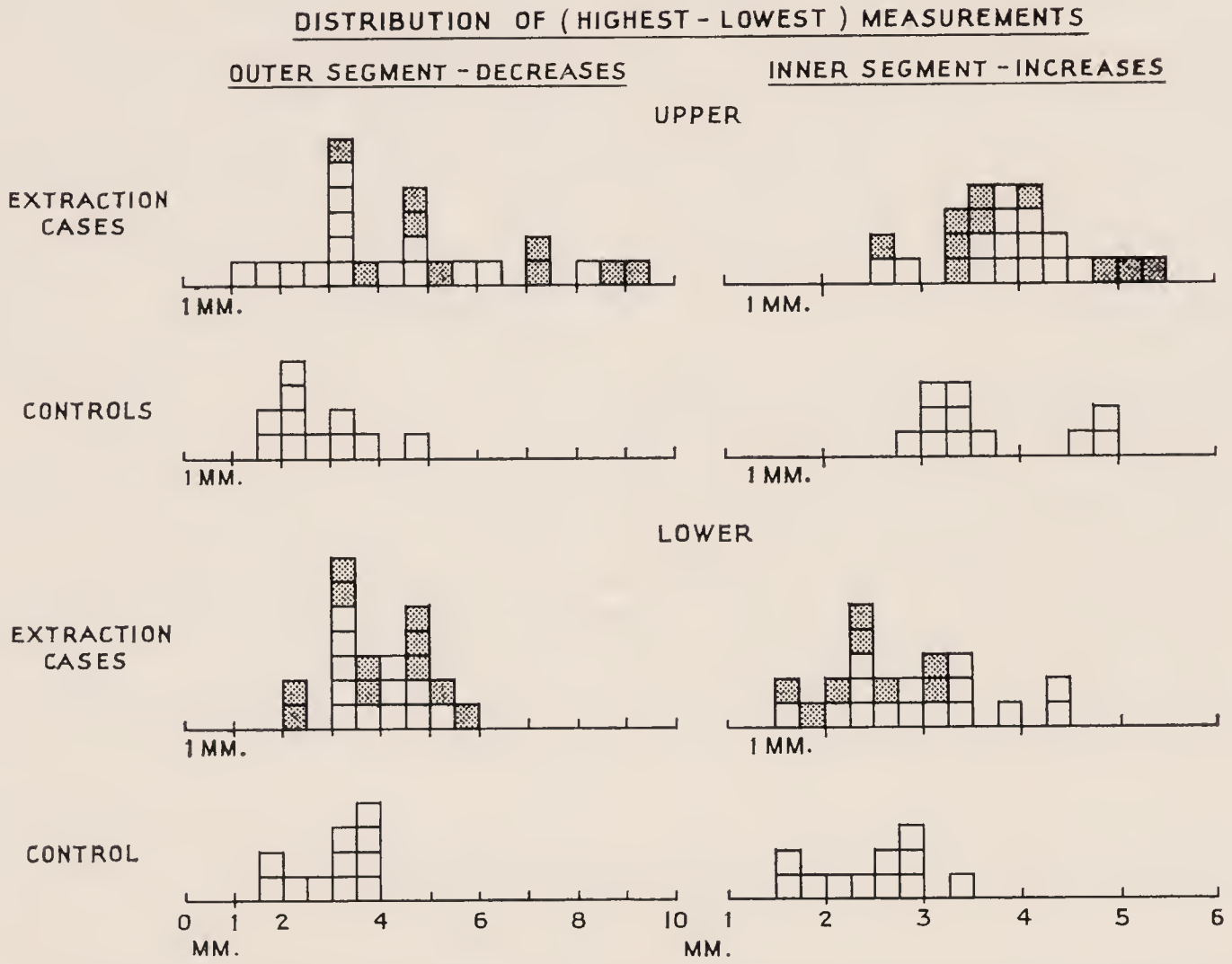


Fig. 13.—Shows the distribution of (highest — lowest) measurements for the four segments in all the extraction cases and in controls. In the control cases the right and left sides are averaged. In the extraction cases the right and left sides are averaged only when the extractions are bilateral. The anomalous value in control *Case* 57 is omitted. Each square is one case. The shaded squares are the cases with extractions before the eruption of the first permanent molars. This demonstrates the greatest degree of either space decrease or increase in each case—some of the decrease and increase may be only temporary in the extraction cases.

To summarize the impressions made by this study of these models, only two definite conclusions were reached: first, that extractions before the eruption of the first permanent molars resulted in permanent loss of space but to a varying degree and more in the upper

than in the lower arch; secondly, that well-developed arches showed little, if any, permanent space loss following later extractions. But it was my impression that even when there was no obvious imbrication there was a tendency to a "tightness" between the teeth, especially the premolars and first permanent molars, which might predispose to interstitial caries. Even a reduction of $\frac{1}{10}$ mm. would make a difference in the pressure at the contact point. As to the extent and area of the changes, each case behaved individually and it was clear that to apply the result of a statistical analysis to any one child would lead to many errors.

It was, therefore, extremely interesting to find that Mr. Healy (who had no preconceived ideas concerning the material as he has no connexion with dentistry) had come to the conclusion from the measurements that it would be useless to evaluate equally the changes occurring in all the material. He has given these figures, but in addition he has shown on graphs the changes in the individual cases where the extractions occurred before the eruption of the first permanent molars. To show more clearly where and when these changes occurred, he graphed both segments of each quadrant as well as the totals for each quadrant as the totals did not show clearly the changes which actually occurred. When measuring the models I had noticed that the addition of the inner to the outer measurement at the period of greatest space reduction obscured this reduction, because at the same time that the space loss was reducing the outer segment measurement the normal expansion in the incisor region during the change from the deciduous to permanent teeth was increasing the inner segment measurement.

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STATISTICAL APPENDIX

(*M. J. R. Healy*)

It will be readily appreciated from Miss Clinch's paper that the material available for analysis was extremely heterogeneous. Not unnaturally, no two cases agreed in the particular teeth extracted and in the age at which extractions took place. On examination, however, it appeared that the cases in which extractions had taken place before the eruption of the 6's showed some degree of similarity, and the detailed comments which follow are mainly concerned with comparisons between these "early" extraction cases and the control series with no extractions.

1. Patterns of Change in the Measurements.—Graphs showing the measurements on selected control and "early" extraction cases are given in *Figs.* 5–10. In the extraction group, the nature of all extractions and the ages at which they took place are given on the graphs, and the age of eruption of the 6's is indicated by a small vertical bar. The four segments will be described separately.

a. Upper Jaw, Incisor-canine Segment.—In the control cases, this measurement undergoes a marked increase, usually extending over a period of 2–3 years, and this is sometimes followed by a slight decrease. The average age at which the highest measurement is attained is about 9 years, but the actual age varies in individual subjects from 7 to 13 years.

The early extraction cases follow a very similar pattern. When extraction was unilateral, the increase tended to be slightly larger on the extraction side; the average difference between the two sides in 8 cases was $0{\cdot}46 \pm 0{\cdot}12$ mm.

b. Upper Jaw, Premolar-molar Segment.—The control measurements in this segment tend to decrease slightly over the period considered, but the change is gradual and rarely

exceeds 3 mm. The early extraction group presents a very different picture. Here extraction is usually followed immediately by a substantial decrease in the measurement ranging from 3 mm. to as much as 9 mm., often followed by a partial recovery.

level of about 7 per cent. As in the upper jaw, early extraction appears to have little effect.

d. Lower Jaw, Premolar-molar Segment.—Again the general pattern resembles that in the upper jaw, the decrease and the control measurements being now rather larger as a

Table 1.—Maximum Increases and Decreases, in mm.

		No. of Cases	*Mean*	*Standard Deviation*
Incisor-canine segment (increase)	*Upper jaw–controls*	11	3·64 ± 0·22	± 0·74
	extractions: early	10	3·92 ± 0·28	± 0·90
	others	14	3·86 ± 0·14	± 0·54
	Lower jaw–controls	11	2·42 ± 0·18	± 0·61
	extractions: early	11	2·62 ± 0·21	± 0·68
	others	12	2·92 ± 0·23	± 0·80
Premolar-molar segment (decrease)	*Upper jaw–controls*	11	2·72 ± 0·29	± 0·92
	extractions: early	10	6·18 ± 0·70	± 2·21
	others	14	3·52 ± 0·36	± 1·36
	Lower jaw–controls	11	3·10 ± 0·24	± 0·79
	extractions: early	11	3·93 ± 0·37	± 1·23
	others	12	3·99 ± 0·21	± 0·73

Certain points of detail may be seen on the graphs (*Fig.* 6). Thus *Case* 20 shows a decrease of 8 mm. on the side on which |E was extracted, while the other side shows a decrease of 5 mm. at a later age. On the other hand *Case* 42, with early extraction of |DE, shows only a small decrease on the opposite side. In *Case* 95, the early extraction was of |D; the late decrease of about 6 mm. on the opposite side may have been associated with the extraction of both lower 6's. An interesting subject is control *Case* 57 which had a large decrease (7·9 mm.) on the right side. This seems to have been due to 6| impacting on and knocking out E| between the ages of 8 and 9, a phenomenon which has mimicked the effect of an early extraction.

c. Lower Jaw, Incisor-canine Segment.—In the controls, the pattern is similar to that in the upper jaw with an early increase in the measurement, but the increase is usually smaller and less abrupt. There is some indication that the increases in the two jaws of the same individual are correlated, the correlation coefficient of +0·58 giving a significance rule. There appears to be no relation between the magnitude of the decreases in the two jaws. Early extraction intensifies the decrease, but the effect is less marked than in the upper jaw.

2. Metrical Comparisons.—The increase or decrease in a particular segment was measured as the difference between the largest and smallest measurements recorded in that segment. In the controls (except for *Case* 57) and in cases with bilateral early extractions, the two sides of the jaw were averaged. The aberrant value for the upper premolar-molar segment in *Case* 57 was omitted.

The mean increases and decreases for the controls, "early" extractions and other extractions are given in *Table* 1. Standard deviations and standard errors of the means are also given.

The actual distributions whose means and standard deviations are given in *Table* 1 are illustrated in *Fig.* 13. Here each square represents one case, and early extractions are distinguished by shading.

3. Relations between Space Loss and Tooth-size.—The relation between total space loss

and initial spacing in the extraction cases is illustrated in *Fig.* 2. Here, total space loss is measured by the decrease between the first and last measurement recorded, and initial spacing by the difference between the initial measurement of the arch and the sum of the breadths of the 5 deciduous teeth. As before, means of right and left sides were taken for cases with bilateral extractions. On 23 cases, significant correlations ($P < 0{\cdot}05$) were found in each jaw, but the correlation was positive ($+0{\cdot}44$) in the lower jaw and negative ($-0{\cdot}44$) in the upper.

Total space loss was also correlated with the total breadth of the 5 permanent teeth, as shown in *Fig.* 3. The correlations were $-0{\cdot}23$ in the upper jaw and $-0{\cdot}44$ in the lower, the latter being significant ($P < 0{\cdot}05$).

4. Measuring Errors.—In order to assess the reproducibility of the measurements, these were repeated after a considerable interval on the arches from 6 subjects and on the teeth for 5 subjects.

The standard deviations of *differences* between repeat measurements were:—

Teeth:	Single tooth	$\pm 0{\cdot}19$ mm.
	Sum of 5 teeth	$\pm 0{\cdot}55$ mm.
Arches:	One segment	$\pm 0{\cdot}28$ mm.
	Sum of 2 segments	$\pm 0{\cdot}41$ mm.

DISCUSSION

Mr. B. C. Leighton said he must congratulate Miss Clinch on the persistence and tenacity which must have been necessary to follow up such a high proportion of cases over so long a period. A wastage of 47 cases out of 106 in 11 years seemed to him very good going. His experience was that the wastage could have been expected to be considerably higher, particularly as he gathered that the patients in question had had no expectation of treatment.

There were quite a lot of difficulties in handling a longitudinal survey over such a long period of time. There was the loss of patients, the conflict with school, the conflict with parents, and the cost of fares. Finally, the ethical problem must have arisen of what to do if one saw something which needed treatment. He found it very difficult to decide whether to tell the parents that some treatment was needed and so destroy the research, or whether to say nothing and feel rather guilty. In quite a lot of cases the whole thing had been solved because he had learnt that the patient was under someone else's care for orthodontic treatment, and as it had appeared that nothing was being done he had not had to worry.

He said he had been surprised to hear that 7 of the patients were lost through illness, and asked whether that meant they had been ill for the whole period, or that they had just missed one of the visits?

He was glad that Miss Clinch had stressed the value of longitudinal surveys, as opposed to transverse ones. As she had said, transverse surveys could be very deceiving, as also could surveys which were insufficiently longitudinal. Many of the findings that Miss Clinch had spoken of confirmed impressions that had been gained in clinical practice—the permanent loss of space was more likely if the extractions were performed early, and greater space loss was produced by the extraction of the second molars than of teeth further forward in the arch. He thought the observation that no loss of space followed in the lower arch in a prenormal case was an important one, as that might save the fitting of quite unnecessary space maintainers.

Mr. Leighton then asked Miss Clinch if any X-rays had been taken of the patients she had mentioned. It seemed to him that the loss of space was sometimes linked with the degree of curvature of the roots of the molars, and that in turn might be linked with the degree of crowding. In smaller arches the roots were more likely to be curved, and in well spaced arches, particularly in prenormal cases, in the lower arch the roots were more likely to be straight. He would also like to ask Miss Clinch about the first case she had shown, regarding which she had said that the space loss of the second deciduous molar was regained by movement of the lower permanent molar. Was there any imbrication of the lower incisors? Miss Clinch had mentioned that the midline had deviated, and he wondered whether crowding in the incisor region had influenced that deviation.

He would like to mention, too, that it had appeared to him, on looking at the models on the screen, that the first molars on the other side of the arch changed in occlusion, in the opposite way and at the same time as the ones that Miss Clinch had been considering. Was it possible that some of the changes in that molar relationship had been mainly due to a change in position of the mandible in occlusion? He wondered, too, if he could ask how Miss Clinch had decided whether the molar had moved forward towards the incisor segment, had fallen back, or had failed to move forward.

Lastly, he would mention muscular environment, particularly in the incisor region. He would calculate that the research, which had extended over a period of 11 years, must have been started perhaps somewhere about 1946, so it was unlikely that Miss Clinch would be able to tell the meeting very much about muscular environment. He wondered, however, whether Miss Clinch could say anything about the environment, particularly the behaviour of the lower lip, in those cases where space had been lost to the front of the lower arch, in the later stages of observation.

Concluding, Mr. Leighton said he would once again congratulate Miss Clinch on a very useful paper, and one which he thought would help in the decision of which cases were going to lose spaces, and which cases were going to need some sort of space maintenance.

Miss L. M. Clinch said Mr. Leighton had asked how people had been persuaded not to go and have treatment when she had wanted to see them, but she was now suffering from having to treat some of them at a much later stage than she would like. She was, however, doing her best to rectify it.

Regarding the loss of patients through illness, Miss Clinch said that there had been a polio epidemic, and two of the children had died, the others being out of action for quite a few years. She had not had the heart to harass them afterwards.

No X-rays had been taken of the cases. Personally she found it very difficult to tell from X-rays much more than what teeth were present.

There had been no imbrication of the lower incisors in the molar rotation case. The occlusion on the other side did not, however, switch round. She had been under the impression initially that it had, but that appearance had been caused by the fact that the lower E was retained, keeping the 6 back, whereas the other E was shed and the upper 6 had moved forward. As soon, however, as the lower E had been shed, the lower 6 had automatically come forward into occlusion. There had not been a change in the mandibular position.

Concerning muscular environment, not even in the 14-year-olds did Miss Clinch know what the muscular environment was. The control cases, it must be remembered, were not necessarily good occlusions. They were completely random, therefore presumably the muscular environment in the control cases would have been just as variable as it had been in the others. Possibly, of course, muscular environment would have had more effect on the break in the arch, but Miss Clinch had not noticed any muscular environment that could account for the differences in the migration of the teeth.

Before opening the meeting for general discussion the *Chairman* asked Miss Clinch if she did not agree that a lower molar which was moving forwards might not easily encourage a forward movement of upper teeth whether or not the upper arch was broken.

Miss L. M. Clinch replied that in an unbroken upper arch she would not have thought so.

The Chairman opened the meeting for general discussion.

Mr. E. K. Breakspear said he would also like to congratulate Miss Clinch on her very remarkable and persistent study. He thought he detected a slight indication of a "cold war" between the cross-sectionalists and the longitudinalists, but he hoped that was not so, because he felt that the two types of study were complementary, and that each one helped the other. An idea begun by a paper such as had been read, led one to look at something else in a cross-sectional study, and that in turn threw more light on the longitudinal.

He would like to make three comments. First, he thought he had heard Miss Clinch say that in 10 out of the 29 cases there had been very little, if any, final space loss in spite of the fact that both D's and E's had been extracted. He thought it was a matter of some importance whether adjacent D's and E's had been extracted together, or whether it had been separate D's and E's, because he had a theory. He was at that moment trying to throw some light upon whether, when the D and E were extracted together, the tongue could get into the space as a space retainer more often than if the teeth were extracted one at a time, and the others "stayed put". He would like comments on that. He might have misinterpreted what Miss Clinch had said.

The second point was the question of the midline. He was, as perhaps some of those present knew, very keen on measuring unilateral extraction cases, which seemed to him to be relatively uncomplicated. He was not at all worried about the midline. Lundström had raised this point with him before, but he still could not see why, if a midline moved, that invalidated the measurement of the loss of space at the point at which it was measured. He would have thought midline movement was one of a number of possible secondary effects which did not make any difference to the basic measurement at the site of the extraction.

The third point was about the cuspal lock. He had been interested to hear that Miss Clinch found that in some cases the cuspal lock had prevented migration, and in other cases it had not. He wondered if there was a teeth-together swallow in the cases where migration had not occurred, which meant that the teeth had been together for a larger portion of the child's waking life.

Finally, Miss Clinch had said that the cases she had mentioned had been individual cases, and that she could not really tell what was going to happen altogether, but he also believed that all were very complex cases. Each case probably had at least half a dozen factors at work. He believed it would be possible, when enough was known eventually to enable all the factors to be tracked down, to make some sort of accurate picture, and in 20 years' time it would be possible to predict with much more accuracy than was possible at present.

Miss L. M. Clinch said she did not think there was a "cold war" between the cross-sectionalists and the longitudinalists. She thought the cross-section was less easy to apply and the results of a cross-sectional survey far more difficult to assess. A longitudinal survey was easier to apply on an individual, as it was possible to see what had been happening right through a case, and one was more likely to be able to see the same thing happening to another individual; but both types of investigation were bound to be useful.

With regard to the extraction of adjacent D's and E's, Miss Clinch said she was unable to give exact information. There had, however, been only 29 cases altogether. Dividing those into bilateral and unilateral extraction, sometimes of lower, lower and upper, teeth in opposite quadrants, it might have been just one or two cases of each at the end.

It had been said that if the midline were to move, it would not matter. Lundström had brought up the matter of the midline, and whether it was legitimate to compare one side with another—an extraction side with a non-extraction side. Miss Clinch thought it did matter, because if, for example, a lower midline moved and then stayed static, one could not have a normal occlusion of molars. All the extra spaces in the lower canine premolar region on one side would be used up by that shift of midline, and therefore the second molars would not occlude anatomically correctly. Surely it made a difference, although it might not be in the actual space loss but in the occlusion? That could, however, be talked over later.

In answer to the question about cuspal locks, and whether there had been a difference in swallowing habit in the cases in which the cuspal lock had kept the space open and those in which it had not, Miss Clinch said she was delighted to be able to say that in the same case the

cuspal lock had kept the space open on one side and not on the other. (Laughter.)

Miss Clinch said she thought there was no doubt, even though it was very difficult to get anything definite out of those cases, that the more one worked on this subject the more likely one was to be able to predict the result. Even now one was more often able to predict correctly which cases needed space retainers and which cases were likely to suffer from extractions and which were not. There was no doubt that, whether cross-section or longitudinal section, the more one learnt the more one would be able to apply later in the treatment of individual cases.

Mr. E. K. Breakspear, speaking again on the subject of the midline, said he thought there was a difference between secondary movement of the midline which might very well be the result of the extraction, leaving the teeth behind the extraction unaffected except by their own migration; and what might be called a primary deviation of the midline due to some other cause, where the whole arch was changed. He could quite see Miss Clinch's point, and he was glad she had mentioned it. If the whole of the arch was in a different relation from the normal, then of course the effects were going to be different on the two different sides; but if the back teeth were more or less normal, and there was simply a movement of the front teeth, he thought that would not affect the space measurement. They would probably, however, resolve the difference when they came to explain exactly what they meant.

The Chairman, in expressing the thanks of the meeting, said the ability to undertake longitudinal studies, as Mr. Leighton had said, required a tenacity and a persistence which were given to very few.

He had been told that women were able to withstand the buffetings of misfortune better than men, and longitudinal studies provided many disappointments.

The Society was fortunate to have Miss Clinch as a member. She combined the persistence of her sex with the tenacity of her race to deal with problems with which men had so little patience.

He was sure that all those present would wish him to express to Miss Clinch, Mr. Healy, and Mr. Leighton the thanks of the Society which would be shown in the usual way. (Applause.)

The Chairman then declared the meeting closed.

HOW MUCH CAN WE HOPE TO REDUCE THE INCIDENCE OF MALOCCLUSION THROUGH PROPHYLACTIC MEASURES?

By Professor **A. LUNDSTRÖM**, *Stockholm*

THE efforts of every medical speciality must be to make itself out of date through such effective prophylaxis that the illnesses or disturbances concerned disappear or, at any rate, get their incidence reduced as much as possible. The aim of this paper is to discuss to what extent this might be possible in the orthodontic speciality. I am, of course, fully aware of the fact that the title of this presentation might seem a bit presumptuous, but I believe, nevertheless, that the importance of the question might justify its discussion, even at the present stage of our knowledge.

Statements of the incidence of malocclusion depend first of all upon how the limit is defined between the normal and the abnormal. In presenting figures of incidence it is desirable to divide malocclusion not only into different types but also into different degrees, depending on the extent of the deviation from the norm.

I would digress too far if I should try here to analyse in any detail the incidence of all the different types and degrees of malocclusion. I will confine myself to mentioning some few investigations which have a bearing on the incidence of crowding, post- and prenormal occlusion, open bite and closed bite. My purpose is just to illustrate what all of us know so well, namely how common such deviations are from that ideal we used to look upon as the only satisfactory goal of our efforts.

We are interested in the first place in the distribution of malocclusion at a stage when the development of the dentition is more or less completed. If we determine the incidence during the mixed dentition period we would, for example, have to allow for the possibility that some of the local crowding registered might change into more or less normal conditions when the premolars erupt. Some cases also get more aggravated with age, as, for instance, the so-called true prenormal cases.

The distribution of crowding and spacing for the teeth in 139 schoolboys from Stockholm of about 13 years of age is shown in

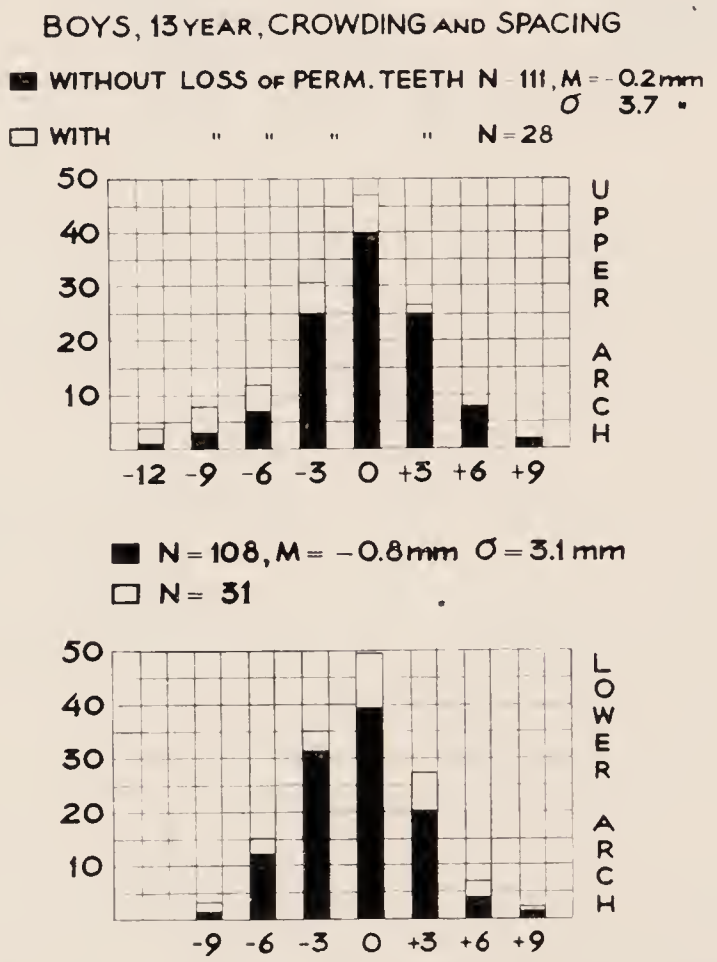

Fig. 1.—Distribution of crowding and spacing (arch-perimeter from M_1 to M_1 minus sum of corresponding tooth-breadths) in 139 boys, about 13 years of age. In cases with loss of permanent teeth an estimated figure is given of the probable space-difference, had the loss not occurred. In the upper jaw, figures obtained have been reduced by 1 mm., as cases without crowding or spacing showed, on an average, a space-difference of about + 1 mm. in this jaw.

Fig. 1. It is obvious that the distribution is more or less similar in the upper and lower jaws. The cases with even dental arches are most frequent, while lack of space seems to be only slightly more common than surplus of space at this age. Some investigations indicate that crowding increases during the

The Twelfth Northcroft Memorial Lecture, given at the meeting held on November 10, 1958.

later development so that the distribution would be somewhat different in the adult from that at 13 years of age.

In *Fig.* 2 the variability of the overjet and overbite is demonstrated. The diagrams are based upon the investigation of Seipel (1946).

Twin-investigations give us an overall picture of the importance of non-genetic factors as compared with that of genetic factors. The type of information such investigations provide is illustrated in *Figs.* 3 and 4, from which it appears that non-genetic factors seem to

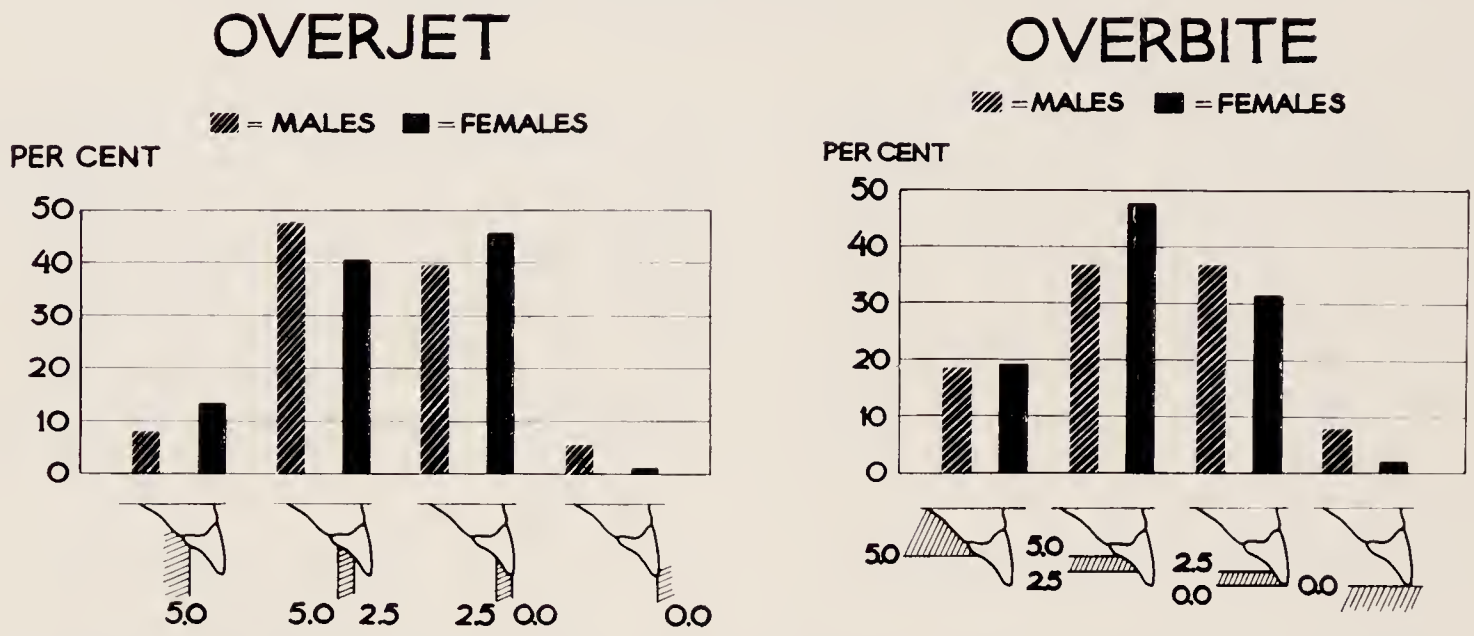

Fig. 2.—Distribution of different degrees of overjet and overbite (38 males and 99 females) in the adult (cases without extractions), according to Seipel (1946).

One can, perhaps, say that an overjet within the limits of 0–5 mm. can be looked upon as almost normal, and in that case about 10 out of 100 Swedes have an excessive overjet and less than 5 out of 100 have a negative overjet with mandibular incisors in front of maxillary incisors.

Corresponding figures for the vertical overbite are 20 per cent with excessive and about 5 per cent with a negative overbite, that is with a space between upper and lower incisal edges, measured at right angles to the occlusal plane.

This may suffice to illustrate the well-known fact that the variability of the human dentition is considerable and comparatively often abnormal to such a degree as to cause the individual troubles of different kinds. I will now turn to the question:—

TO WHAT EXTENT IS THE TOTAL VARIABILITY DUE TO NON-GENETIC FACTORS?

In an attempt to answer this question we have two types of evidence to consider, that is twin-investigations on one hand and special investigations into the role of separate environmental factors on the other.

have less influence than the genetic in causing deviations from the mean. This is in agreement with the findings related to other anthropological characteristics.

But before we can state that our prophylactic possibilities are quite limited, we must know to what extent the genetic variability is due to the direct effects of the genes and to what extent to indirect effects that may be influenced by prophylactic measures. Examples of such indirect influences are inherited tendencies to finger-sucking and to a high susceptibility to dental caries, giving an increased incidence of early loss of deciduous teeth. It is impossible to calculate the relative importance of direct and indirect genetic influences through comparison of mono- and dizygotic twin-pairs. Generally speaking, indirect genetic factors can be of some importance in the genetic variability under two conditions: (1) In connexion with such environmental factors that are potent in causing malocclusion; and (2) If monozygotic co-twins are more equally exposed to these factors than dizygotic co-twins.

In order to get any further it is therefore necessary to discuss these two questions in relation to those environmental factors which

ean be believed to have some definite part in the aetiology of malocelusion.

We must consequently first decide which environmental factors must be considered. The following list would seem to include all those faetors that have been discussed in the literature: (1) Maternal complaints during

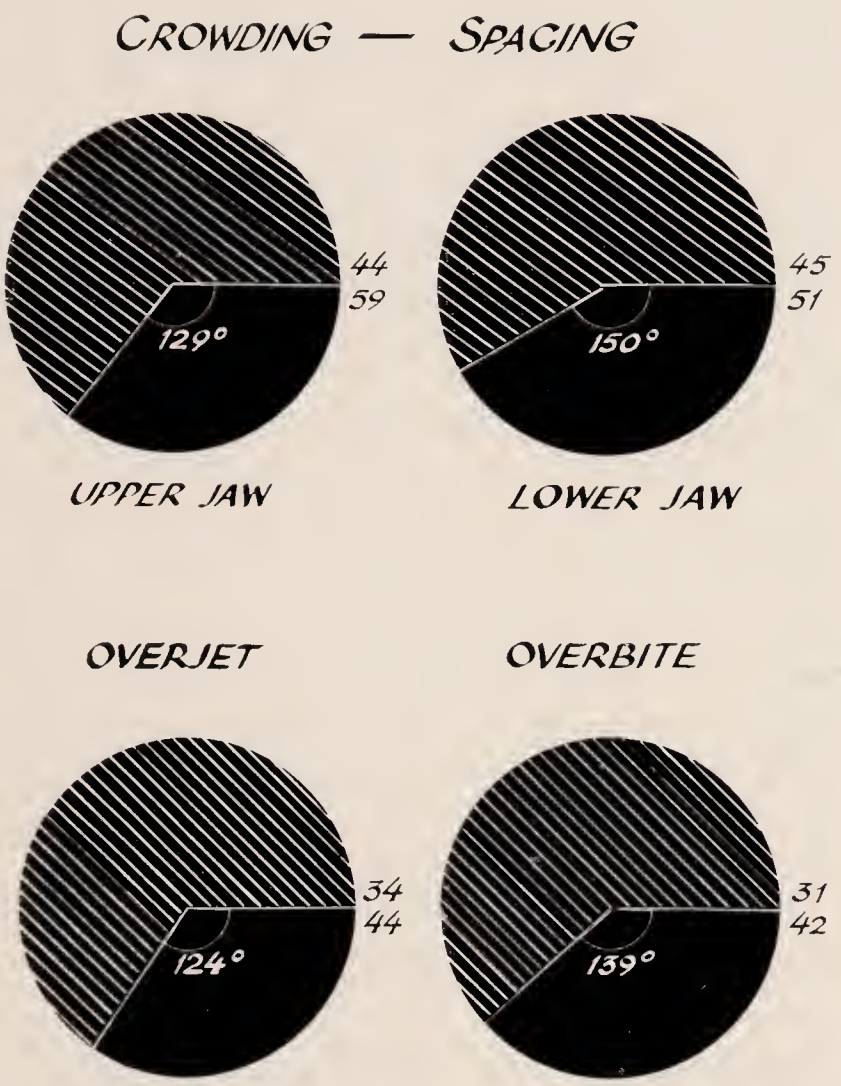

Fig. 3.—Relationship between genetie (striped area) and non-genetie (black area) variability, aecording to an investigation on 202 pairs of twins (100 monozygotic and 102 dizygotie pairs) as regards erowding-spaeing, overjet and overbite. Only twin-pairs without missing teeth were used for these ealculations whereby the number of pairs was redueed to the extent shown in the diagrams. Upper figures give the number of dizygotie, lower of monozygotie pairs. (Lundström, 1948.)

pregnaney; (2) Birth trauma; (3) Bottle feeding; (4) Deficieney of accessory faetors in the diet; (5) Morbid eonditions in the ear, nose, and throat regions, mouth-breathing; (6) Illness of other kind than that due to (4) or (5); (7) Food softness and lack of exercise of the jaws; (8) Finger-sucking and other habits; (9) Early loss of deeiduous teeth; (10) Loss of permanent teeth; (11) Trauma and other aceidents.

I would now like to try to evaluate each of these groups briefly. Trying to eover so mueh material in one single paper will necessitate generalization to an extent that may be misleading, especially where the literature is controversial. It is therefore not improbable that some of you here will disagree with my interpretation of our knowledge on these problems. If that is the case I will be only too

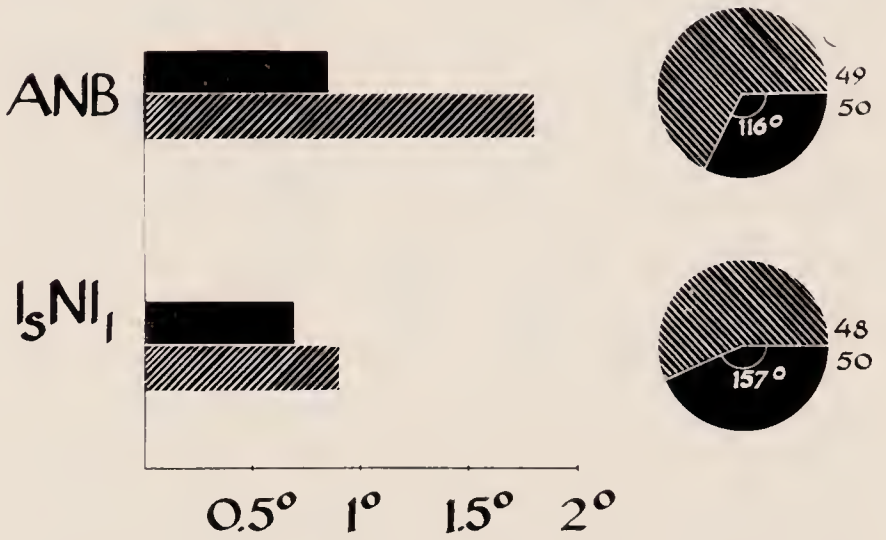

Fig. 4.—Non-genetic (black bar and area) and genetie (striped bar and area) variability as regards the angles subspinale–nasion–supramentale (ANB) and incision superior–nasion–incision inferior (l_sNl_i) aeeording to an investigation on 100 pairs of twins (50 monozygotie and 50 dizygotic same-sexed pairs). (Lundström, 1955.)

happy if you would raise such questions in the discussion.

1. Maternal Complaints during Pregnancy. —There seems to be no clear-cut evidence as to any association between maternal complaints during pregnaney and developmental disturbances resulting in malocclusion of the ehild.

It has been suggested that a virus disease of the mother may have a bearing on the faeial development of the child, as it has been proved that rubella in the first 3 months of pregnaney can cause certain other anomalies sueh as congenital heart-disease, hearing defects, congenital cataract, and so on. A recent finding showing a significant difference between "rubella children" and controls as to the head circumferenec in relation to body-length adds interest to the question of the relationship between the health of the mother and malocelusion (Lundström, 1958).

So far there is no evidenee, however, indieating that prophylaetic measures in order to improve the condition of the mother during pregnaney would result in any deerease in the incidence of maloeclusion.

2. Birth Trauma.—Special investigations (Hofbauer, 1943; Clinch, 1949) have shown that complications in connexion with delivery do not generally cause malocclusions. The finding by Dahlberg (1926) that the first-born of monozygotic twins seems to have a somewhat more dolichocephalic head and a somewhat higher face than the second-born may perhaps indicate that at least a long and difficult labour could have some influence also on the jaws. However, as far as can be seen from the evidence at hand, this factor is a minor one in the aetiology of malocclusion.

3. Bottle Feeding.—In some of the textbooks we are told that bottle feeding is very inferior to breast feeding, as the full growth of the lower jaw is said to require the functional stimulation of breast feeding. The investigation of Humphreys and Leighton (1950) seems to prove that this statement belongs to the type of speculation that through authoritative repetition acquires a false air of being a proven fact. As far as I can see, it is not very probable that the use of those specially devised bottles, which keep the lower jaw a little bit forward during the sucking, would lead to any decrease in the incidence of postnormal occlusion.

4. Deficiency of Accessory Factors in the Diet.—We have all of us seen those illustrations in the literature that show severe abnormalities of experimental animals in the growth of the jaws and face following the more or less complete lack of different vitamins in the food. In man the effect of rickets has been discussed especially, because extreme types of a saddle-shaped upper jaw and open bite often seem to be combined with severe hypoplasia of the enamel and a history of rickets. Investigations, such as the one by Friel (1922) just after World War I, show, however, that the effect of rickets is not so easily defined. A child may very well have had rickets and still get no malocclusion. Neither is there any general association between hypoplasia of the enamel and a saddle-shaped upper jaw or open bite.

It is possible that only very severe rickets or similar disease for many years without any treatment will produce the symptoms mentioned. Further research is certainly necessary before we can determine the role of rickets and other deficiency diseases in the causation of malocclusion. Much has, of course, already been done to ensure that our children get a fully satisfactory diet. On account of this it is doubtful if further steps in this direction will help to any extent in reducing the incidence of malocclusion.

5. Morbid Conditions in the Ear, Nose, and Throat Regions (Mouth-breathing).—In discussing ear, nose, and throat disease and its significance in our field, such an obvious and extremely rare condition as the so-called "Vogelgesicht" following early ankylosis of the mandibular joint can be passed over. The problem is what association there is between the so-called adenoid type of child with more or less complete mouth-breathing and special types of malocclusion, and how to interpret such an association. Systematic observations, such as the one by Humphreys and Leighton (1950), suggest that the association between mouth-breathing and the type of occlusion is weak. It is, furthermore, conceivable that any relationship between the two should be interpreted not as cause-and-effect but as a combined result of a third condition, e.g., a generally narrow type of face. There is an obvious need for further research into these questions before we can draw any definite conclusions.

6. Illness of Other Kind than due to Food Deficiency or Ear, Nose, and Throat Defects.—There seems to be no evidence indicating that ordinary diseases of children, such as exanthematous fevers, have any significance in the aetiology of malocclusion. Such diseases generally are so short in duration that it is rather improbable that any such association could exist.

One general disease, which in rare cases seems to interfere with the growth of the lower jaw, is rheumatic fever. In cases with a chronic rheumatic arthritis in the mandibular joint the child can show a similar arrest of the condylar growth, as when suppurating otitis media spreads to the joint.

Other disease of a more severe character might possibly have some influence on the development and growth of the jaws and thus be the cause of malocclusion. It must be stated, however, that our evidence of such causal relationships is very unsatisfactory. We cannot, at the present time, name any illnesses that, even in their severe forms, will give specific growth disturbances predisposing to certain, well-defined malocclusions. We lack conclusive evidence as to the true effect in this respect also of different hormone diseases. I am excluding congenital deformities such as cleft palate, dysostosis cleidocranialis or cranio-facialis, and so on, in this connexion, as such conditions can hardly be classified as diseases in the general meaning of the word.

7. Food Softness and Lack of Exercise of the Jaws.—The significance of mastication as a stimulus to jaw-growth has been studied experimentally through unilateral grindings, extractions and operations, and the degree of asymmetry has been used as evidence.

forces to a more intense chewing of harder food produce larger dental arches or better occlusion with, for instance, less postnormal

Fig. 5.—Numbers and percentages of twins without (O) and with finger-sucking up to different age-stages. One case still sucking at 13 years and two who could not tell when their finger-sucking stopped were not included.

occlusion than we have got to to-day? Watt's and Williams's (1951) experiment on growing rats with two groups of animals, fed on the same food except for consistency, can be applied to the problem, but the difference in

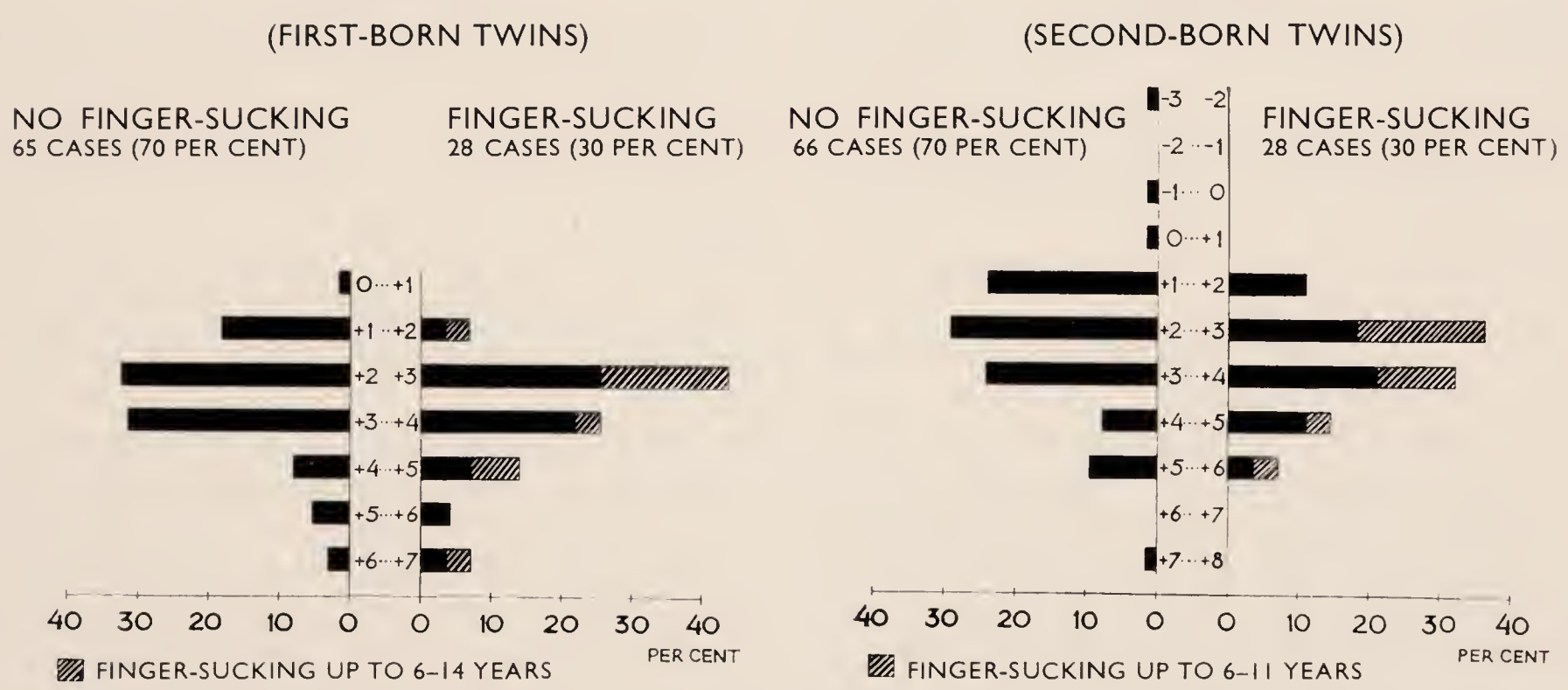

Fig. 6.—Distribution (in per cent) of the overjet in 131 twins who never sucked the fingers, and in 56 twins with a history of finger-sucking.

Such experiments are rather artificial. It is, therefore, difficult to draw any conclusions from them, which can be applied to the real problem. This can be formulated thus: Would a change from the moderate present-day mastication hardness was so extreme that even this investigation cannot give us the evidence required to answer the question. Personally, I must admit that I would be astonished if further research could prove that the use of harder food would

decrease the incidence of malocclusion to any extent worth mentioning.

8. Finger-sucking and Other Habits.—Every orthodontist knows that finger-sucking and other habits involving oral pressures can be the cause of more or less marked deformities of the arches, especially regarding the position of the front teeth. The effect of these habits depends most probably in the first place upon the intensity (force and duration per 24 hours).

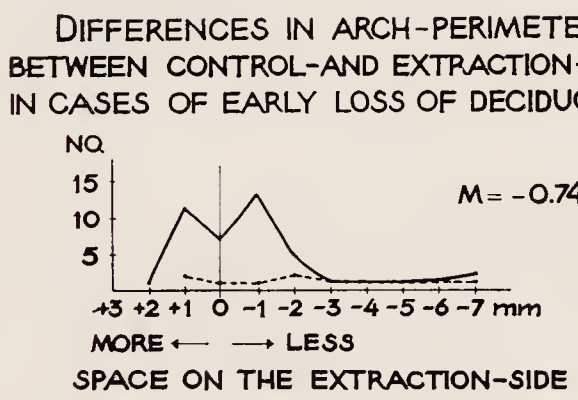
DIFFERENCES IN ARCH-PERIMETER
BETWEEN CONTROL-AND EXTRACTION-SIDES
IN CASES OF EARLY LOSS OF DECIDUOUS MOLARS.
NO.
15
10
5
M = -0.74 ± 0.30 mm
+3 +2 +1 0 -1 -2 -3 -4 -5 -6 -7 mm
MORE ← → LESS
SPACE ON THE EXTRACTION-SIDE

Fig. 7.—Distribution of 41 cases with early unilateral loss of deciduous molars as regards difference between control side and extraction side in length of arch-perimeter from contact-point between medial incisors to distal contact-point of first permanent molars. Dotted line shows cases for which the loss occurred before school-age (school starts in Sweden in the year when children are 7 years of age). (Linder-Aronson, 1958.)

An essential problem is this one: How often will finger-sucking result in a lasting malocclusion? In order to contribute to this question I have collected data on any finger-sucking among 196 twins and one set of triplets from their mothers. The results are given in *Figs.* 5 and 6 and in *Table I.*

It should be mentioned that in most of the cases with finger-sucking the habit had stopped some considerable time ahead of the investigation. From this point of view the cases were distributed in the following way:—

Table I.—Overjet and Overbite (in mm.) in Twins without and with Finger-sucking and in Twins with Prolonged Finger-sucking

		First-born Twins		Second-born Twins	
		Overjet	*Overbite*	*Overjet*	*Overbite*
No finger-sucking	N	62	65	65	65
	$\bar{x} \pm \epsilon(\bar{x})$	3·0 ± 0·19	2·7 ± 0·18	2·7 ± 0·18	2·7 ± 0·23
	S	1·51	1·41	1·47	1·85
All finger-suckers	N	29	29	27	27
	$\bar{x} \pm \epsilon(\bar{x})$	3·1 ± 0·25	3·3 ± 0·23	3·1 ± 0·23	2·9 ± 0·25
	S	1·34	1·25	1·17	1·31
Finger-suckers up to 6–14 yr.	N	10	10	10	10
	$\bar{x} \pm \epsilon(\bar{x})$	3·1 ± 0·46	3·7 ± 0·37	3·1 ± 0·36	3·1 ± 0·36
	S	1·45	1·16	1·13	1·45

(N = number of cases, $\bar{x}$ = mean, $\epsilon(\bar{x})$ = standard error of mean, S = standard deviation)

Finger-sucking up to	No. of Cases	Number of Years without Finger-sucking at Examination	
		Average	*Range*
1–5 years	42	9·9	4–15
6–14 ,,	24	5·8	0–11*

* 6 cases had stopped their sucking 0–3 years before the examination (1 of these still sucked, at the age of 13 years)

Some cases were not used for *Fig.* 7 and *Table I* for various reasons, mainly on account of orthodontic treatments. As this reduction of the material might have influenced the results, it is necessary to give an account of these cases:—

Out of 5 cases without finger-sucking not used in *Table I*, 4 (3 first-born and 1 second-born) had undergone simple treatments (biting on a spatula, grinding) in order to correct a tendency to lingual occlusion of upper incisors to lower. One had had a fracture of the upper central incisor-crowns and could not therefore be measured.

Out of 11 eases with finger-sucking not used, 8 had had orthodontic treatments. Two of these were of the same kind as mentioned above, 6 had undergone more complieated treatments, while 3 cases were exeluded for non-orthodontie reasons.

The fact that 6 (in 4 pairs) out of 67 eases with finger-sueking had got definite orthodontic treatment while none of 132 cases without finger-sueking was reported to have been treated in the same way, may suggest some association between finger-sucking and obvious malocclusion. One must then first of all ask if the 6 eases mentioned were such that had an excessive overjet or overbite before treatment. The following data were obtainable for these cases:—

Twin-pair	Finger-sucking up to (Yr.)	Diagnosis	Age	Overjet	Overbite
			Before Treatment		
II 40 b	4	Ling. occl. $\frac{B\|}{}$ and $\frac{C}{-}$	6	1–2⋆	0–0·5⋆
I 80 b	5	Bimax. crowding	8	2·8	1·6
I 80 a	6	Bimax. crowding	11	5·0	2·1
I 15 a	6	Bimax. crowding	10	Normal	3
I 15 b	6	Bimax. crowding	10	2·0	2·3
II 7 b	10	Postnormal occlusion	12	3·5	1·7

⋆ Deciduous teeth

I = monozygotic, II = dizygotic; a = first-born, b = second-born

It does not seem as if the exelusion of these cases from *Table I* has affected the results to any extent.

The eonelusion from these findings seems to be that most finger-suekers do not get any marked, lasting effect from their habit. This is in agreement with the findings of some authors that there is a definite tendeney to self eorrection of finger-sucking anomalies when the habit diseontinues (Lewis, 1930; Kjellgren, 1939; Seipel, 1948 b).

This does not, of course, mean to say that we do not, in some cases of finger-sueking, get such effects. From a prophylaetie point of view it may be asked if one should teaeh all mothers to stop any finger-sueking of their children as soon as it is observed. The fact that the majority of finger-suckers do not seem to be harmed by their habit makes me feel that we should not go so far.

It is impossible to tell if proper feeding and eare of the small ehild could reduee the ineidenee of finger-sueking. Obviously, everything that can be done along these lines ought to be done, and if this prevents finger-sucking to some extent it might be of some help also for us.

The findings of Klaekenberg (1949) and Humphreys and Leighton (1950), indicating that the usage of comforters might reduee the ineidenee of prolonged finger-sueking, ought to be eonsidered. I am, so far, hesitant regarding the advisability of any general reeommendation of this kind.

We will probably, also in the future, have to take eare at a later age of a certain number of prolonged suekers that seem to have got a maloeclusion that will not eorreet itself if we do not interfere. This may be looked upon as a defeatist attitude, and I would be interested to hear if anybody has got another opinion on this matter.

9. Early Loss of Deciduous Teeth.—The effeet of early loss of deciduous teeth is varying and dependent on such faetors as: (*a*) Which tooth or teeth are lost; (*b*) At which

developmental stage the loss occurs; (*c*) The amount of space for the teeth within the arches.

Seipel (1948 a), Breakspear (1951), and, recently, Linder-Aronson (1958) have all studied the effect of early loss of deciduous teeth by comparing left and right sides in cases of unilateral loss. The last investigation may be unknown to this audience, being, so far, published only in Swedish. I would, therefore, like to show the type of curve all the three authors have obtained, by using Linder-Aronson's diagram (*Fig.* 7). It shows, as you can see, that many cases in spite of their unilateral loss (which in the majority of cases occurred after the eruption of the first permanent molars) got symmetric arches. Others, however, show asymmetry in varying degree from 1 mm. up to 7 mm. in the most extreme case.

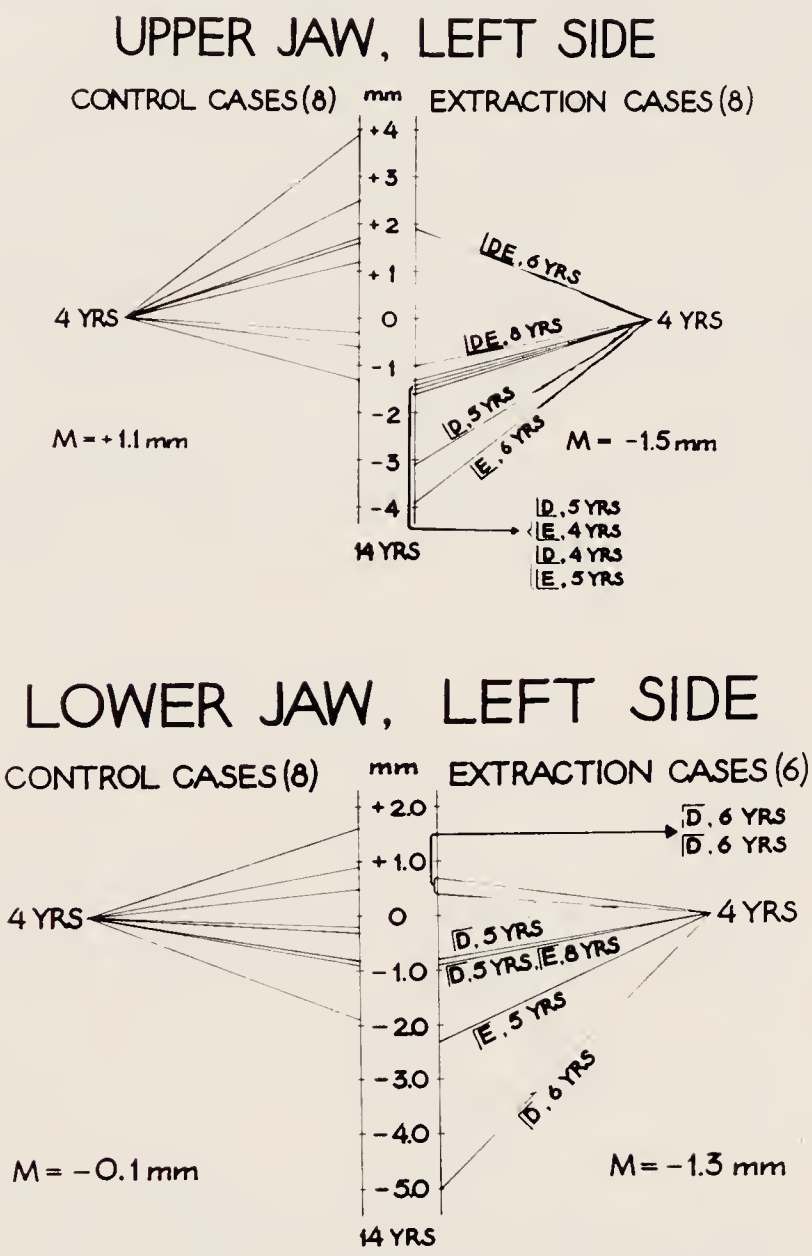

Fig. 8.—Changes in the arch-perimeter from midline to distal of E (medial of M_1) from 4 years to 14 years in cases with early loss (before eruption of M_1) of deciduous molars (Clinch, 1959).

Clinch (1959) found on her extremely valuable material of longitudinal observations that many cases after the loss of a deciduous tooth first showed a pretty large decrease of the arch perimeter but then, gradually, a more or less marked reverse migration as the premolars and canines started and completed their eruption. I would like to present two illustrations showing some of her findings (*Fig.* 8), and at the same time I want to thank her for letting me use her material.

On account of the varying effect of early loss of deciduous teeth, it is very difficult to form an opinion about how much one could hope to reduce the incidence of, for example, crowding if all deciduous teeth could be kept in their full natural size up to their normal shedding stage. Some reduction would be obtained, but perhaps not too much of it.

Another problem is to what extent the overjet or overbite can be influenced by early loss of deciduous teeth. According to Pringle's (1939) observations one might get an increased overbite at 7–8 years of age with loss in the lower jaw. We are, again, most interested in final effects and, therefore, the condition at 13–14 years of age. Personally I could find no such difference in a material of 118 cases (1955).

I do not, therefore, believe that early extraction of deciduous teeth is an important factor in the overjet–overbite variation.

There is a great need of more evidence as to the effect of extraction, as well as abnormal reduction through caries, of mesiodistal diameters of different deciduous teeth at definite developmental stages in different types of cases.

10. Loss of Permanent Teeth.—If extraction of permanent teeth is performed during the development of the dentition, migrations of the neighbouring teeth take place, and result, as we all know, in a varying degree of closure of the gaps.

It is impossible to go into details here as to which consequences can result from various extractions of permanent teeth at different ages in normal and abnormal cases. Our knowledge is also in this respect far from satisfactory. One of the problems discussed in the literature is whether the incisor overbite will be increased by an early extraction of all the

four first permanent molars. Many authors are quite definite in claiming such an effect but very little evidence has been produced to prove it.

One of the latest investigations published is by Lysell (1957), and he could find no significant difference at the age of 14 years in either the overbite or overjet between 18 cases with extractions at 7–8 years of all first permanent molars and 23 control cases without any extractions of permanent teeth.

Filipsson (1958) examined profile radiographs of the same cases as Lysell and he could not find that extraction of the first permanent molars had any effect on the general growth of the jaws. Early extraction of other teeth than molars is not so common, which may be the reason why their effect has not been studied in a systematic way. Clinical experience seems to suggest that such extractions constitute only a local influence in the aetiology of malocclusion.

It thus seems rather improbable that the large variation shown in the population in overjet and overbite is due to extraction of permanent teeth to any degree worth mentioning.

11. Trauma and Other Accidents.—In cases of this kind the aetiological mechanism is mostly obvious. Certain types of malocclusion (proclination of upper front-teeth) predispose, of course, for traumatic injuries, showing again the interaction between different factors. In cases of a combination between accidents and other malocclusion it can sometimes be difficult to ascertain to what extent the status presented is a consequence of one or the other type of aetiological influence. This is true especially if some considerable time has passed after the accident until the case is examined.

After this synopsis regarding the effect of different external factors in the aetiology of

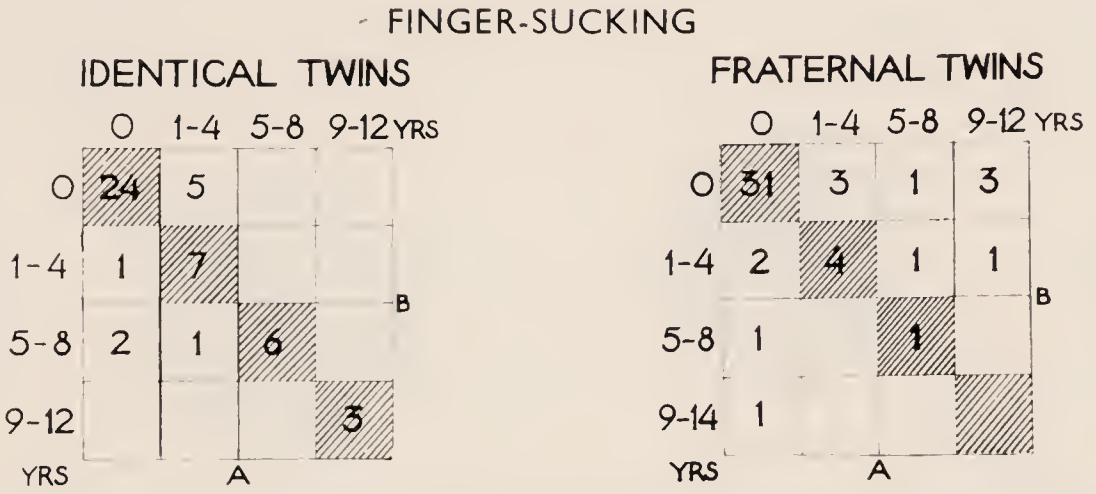

Fig. 9.—Similarity (striped squares) and dissimilarity in finger-sucking in monozygotic and dizygotic twin-pairs. A, First-born twin; B, Second-born twin.

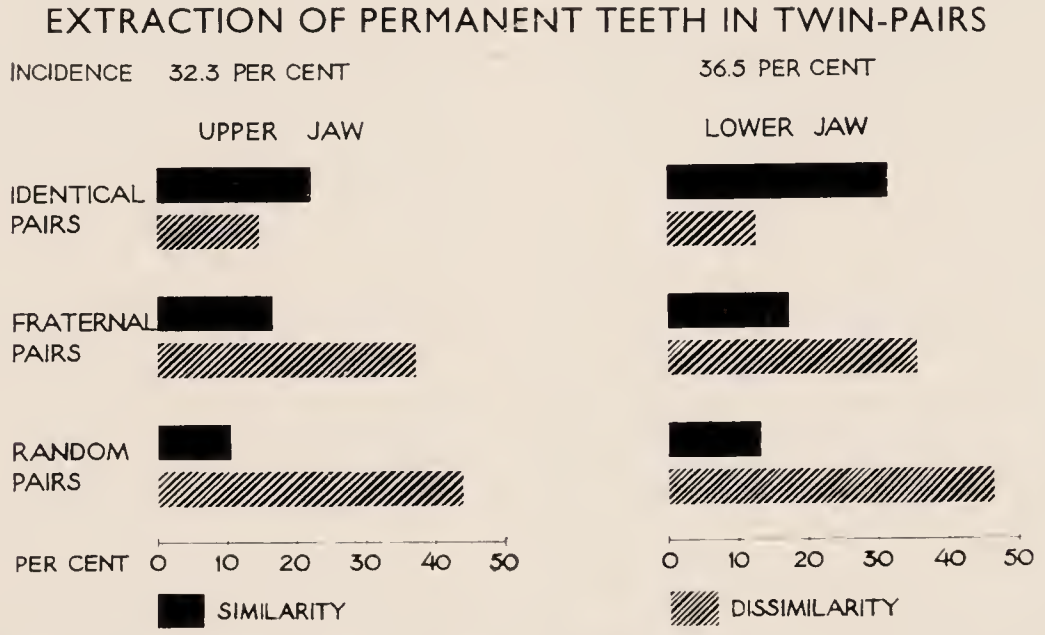

Fig. 10.—Incidence of similarity (concordance) and dissimilarity (discordance) in the extraction of permanent teeth in monozygotic and dizygotic twin-pairs. For comparison the theoretical distribution in random pairs is also given. The incidence of similarity is significantly larger in monozygotic twin-pairs than in dizygotic pairs and random pairs. (Lundström, 1948.)

malocclusion, I would like to return to the problem to what extent the genetic variability may be due to genetically controlled, environmental factors. That such factors may show a stronger tendency to coincide in monozygotic than dizygotic twins is demonstrated in *Fig.* 9, showing similarity and dissimilarity

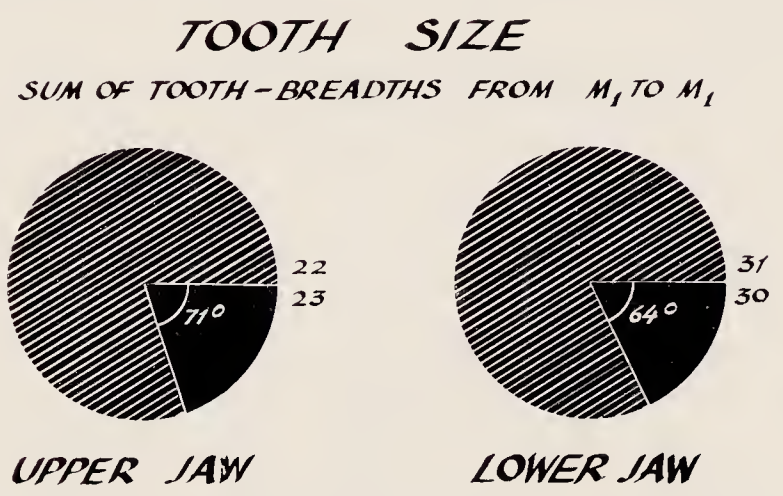

Fig. 11.—Relationship between genetic (striped area) and non-genetic (black area) variability as regards sum of tooth-breadths from M_1–M_1, according to an investigation of 202 pairs of twins. On account of fillings, extractions, hypoplasia of the enamel, non-erupted teeth the calculations are based on only 23 mono- and 22 dizygotic pairs for the upper jaw and 30 mono- and 31 dizygotic pairs for the lower jaw.

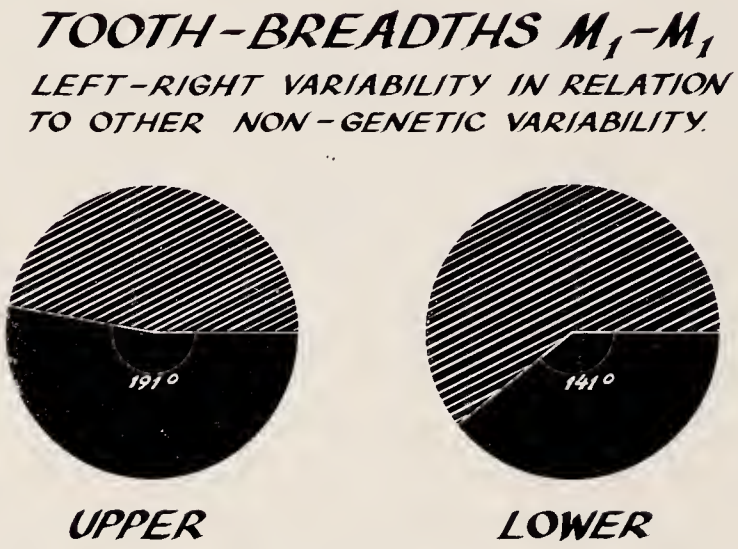

Fig. 12.—Relationship between left–right variability (striped area) and non-genetic variability of a symmetric character (black area) as regards sum of tooth-breadths from I_1 to M_1. The calculations are based on 49 left–right pairs and 23 monozygotic twin-pairs for the upper and 63 left–right pairs and 29 monozygotic pairs for the lower jaw.

in finger-sucking among the two types of twins.

It is very probable that other environmental factors of interest to us are also more equally distributed in the monozygotic than in the dizygotic twins. Dissimilarity as to extraction of permanent teeth is for instance less frequent in the first than in the second type of twins, as demonstrated in *Fig.* 10.

Most probably the same rule applies to extraction of deciduous teeth, which may be one reason why dizygotic twins show more crowding-differences than monozygotic twins.

The general conclusion of these considerations must be that the genetic variability, which we can obtain through statistical calculations on twin-data, is to some extent due to a direct influence on the development from the genes and to some extent to secondary effects from environmental factors which are more or less under genetic control.

Under such circumstances, it must be possible to influence and reduce also that part of the total variability which the twin-investigations show to be of a genetic nature. How much we can hope to do this it is very difficult to say. Personally, I do not think we can be very optimistic in this respect, considering that most external factors seem to have a very irregular effect and that their genetic control is only partial.

Let us now turn to the non-genetic variability and discuss to what extent we may reduce this through suitable prophylactic measures.

In order to throw some light on this problem it seems best to start with an analysis of the non-genetic variability in tooth-size. The teeth have two advantages over most other variables of the jaws, namely their sheltered position during development, and their bilateral character, which makes it possible to compare not only twin-differences but also the right and left sides of the individual.

The relationship between the genetic and the non-genetic variation of the sum of tooth-breadths from first molar to first molar is shown in *Fig.* 11. The genetic variation is a little more than four times as large as the non-genetic. The question is now: What constitutes this non-genetic variability? In order to get some background to this problem it is of interest to discuss the variation which can be derived from the differences between the right and left sides.

If corresponding teeth on the right and left sides are assumed to be genetically identical, such bilateral differences in tooth-size as can be observed should have some kind of non-genetic origin. It is very difficult to name any definite external influence which could cause a tooth to get smaller or larger than it should be according to genetic control. The most likely explanation of such right–left differences is, instead, that they are an expression of random deviations in the internal environment of the body.

In other words, the precision of the genetic control in a certain external environment may not be absolute, and the final size and form of any organ may, within certain limits, deviate a little in a positive or negative direction from what the gene-combination would, on an average, produce under given circumstances.

It seems very likely that the right–left differences in tooth-size depend, on the whole, on such a lack of precision of the genetic control. If that is so, it is possible to assess for this character to what extent the total non-genetic variability is due to environmental influences with symmetric effect or to a random variation of the same character as causes differences between right and left sides. *Fig.* 12 gives an illustration of such an assessment for the sum of tooth-breadths from first molar to first molar in the upper and lower jaws.

One general conclusion can be drawn from these findings: we can expect to reduce the total non-genetic variability only partly through prophylactic measures. We can never hope to be able to influence these random developmental deviations, which certainly concern not only tooth-size but all other organs in the body. Some of our malocclusions may very well be explained on this basis.

Finally, I will now return to the question in the title of this paper. My conclusion, or perhaps I should say my present opinion, about the answer is probably best illustrated graphically.

Fig. 13 indicates the way a total variability is composed of two independent variations working together. It is also possible to see how much the total variability would be reduced if it were possible to eliminate completely the non-genetic variability. It would obviously give only a moderate reduction. From what has been said in the foregoing we could most probably eliminate only some part of the non-genetic variation through prophylactic measures. On the other hand, it might be possible to reduce also the genetic variation somewhat, in so far as this is due to genetic influences of a secondary nature. Even if this

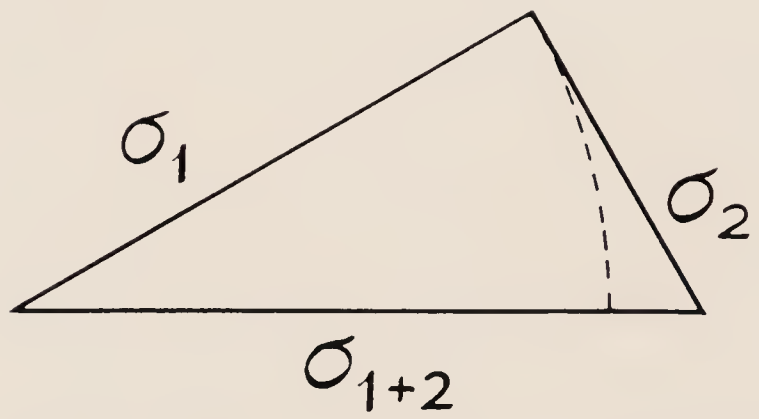

Fig. 13.—Total (σ_{1+2}), genetic (σ_1), and non-genetic (σ_2) variabilities and their relationship to each other according to calculations on twin-data. If a complete reduction of the non-genetic variability could be achieved the total variability would be reduced to dotted line (cf. text).

is so, it does not seem very probable, at the present stage of our knowledge, that prevention, in the true sense of this word, can result in anything more than a fairly moderate decrease in the incidence and degree of malocclusion. Further research is necessary, however, before we can give a more definite answer to this important question.

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DISCUSSION

Miss L. M. Clinch said she would like first to thank Professor Lundström for his very comprehensive survey of what was known, as distinct from what might be vaguely guessed, concerning the causes of malocclusion which it might be possible to prevent. She thought one of the principal functions of the opener of a discussion was to start an argument. In this case it was not easy, but she would do her best.

With reference to the incidence of malocclusion, there was no doubt that orthodontists were in danger of assessing the number of children needing orthodontic treatment as much higher than it really was because, day after day, they saw only malformations. A child with good occlusion appearing in an orthodontic practice was like a good deed in a naughty world. If they went out into highways and hedges and, even better, the orphanages, they would get, she thought, a pleasant surprise. She believed few of them would have thought that lack of space was only slightly more common than too much space at 13 years of age.

Incidentally, she would like to ask what was surplus space? In the upper arch some spacing was essential, she believed, if there was to be no crowding in the lower. Could that be called surplus space?

She would also like to know what Professor Lundström defined as excessive overbite, and why? She could find no difference in the degree of overbite between her extraction and non-extraction cases.

She hardly liked to make any query concerning genetic and non-genetic factors to such an expert on the subject, but some of the slides they had seen showed that, to quote, "non-genetic factors seem to have less influence than genetic in causing deviations from the mean". In what way could the mean, in that connexion, be related to an individual child who might or might not need orthodontic treatment? She understood that the mean was the same as the average, but could they base their opinion on the necessity for orthodontic treatment on deviations from the average? Surely deviations from some standard such as the ideal or the anatomically correct was what should interest them.

She was glad that Professor Lundström did not interpret the connexion between mouth-breathing—or rather between the child who looked like a mouth-breather—and malocclusion as cause and effect. It seemed much more probable that the two anomalies were caused by a third condition, which they were unlikely to be able to influence. That condition, however, often affected the maxilla more than the mandible, resulting in a lingual occlusion of the maxillary cheek teeth. That could be corrected easily in the mixed dentition and a more severe malocclusion, which was much more difficult to correct satisfactorily at a later stage, would be prevented.

She agreed that the ordinary diseases of children were unlikely to have any direct influence on the aetiology of malocclusion, but would Professor Lundström agree that they could in isolated cases cause an alarming increase in caries incidence or that, if they occurred in infants, they could interfere with the calcification of the teeth, making those more caries prone at a later stage, and thus having a possible indirect effect on the occlusion?

Should nothing be done about children with habits which were causing deformities of the dental arches? It had been her experience that in 90 per cent of cases a talk to the child alone, lasting a minute or two, would be enough to stop the habit. She would certainly be loath to abandon that simple procedure, and incidentally she thought it would be fatal to leave the task of stopping the habit to the mother, because children were conditioned to putting up a resistance to "dont's" from their parents and usually just did not listen. A few words from a stranger in strange surroundings usually made a lasting impression. Those who were not impressed might as well be left until a later age anyhow, as they had no intention of co-operating and would be hopeless patients.

One type of malocclusion which in her opinion was often caused by thumb-sucking, and should be corrected early because it was doubtful if it could correct itself, was a crossbite, with the upper molars on one side lingual to the lowers. She would also like to know if Professor Lundström thought that tongue-thrusting might be secondary to finger- or thumb-sucking? In other words, did he think that when the sucking habit produced an open bite the tongue pushed through it? It was known that in swallowing, the sides of the tongue would protrude through a gap where a tooth had been extracted. Was it not possible, then, that the tip of the tongue protruded through a gap between the incisors just because the gap was there? If Professor Lundström thought that was a red herring, there was no need for him to answer! (Laughter.)

She had recently spoken at length about the effects of early loss of deciduous teeth. Would Professor Lundström agree that even if malocclusion were not caused to any great extent by early loss of deciduous molars, a malocclusion which was already present might be complicated to such an extent that a satisfactory result of treatment might be rendered impossible? It seemed to her that it was the children with malocclusion who needed to retain their deciduous teeth to their normal shedding time in order to prevent a more severe malocclusion from developing.

In conclusion, she thought perhaps they were seldom able to prevent a malocclusion from occurring, but they might be able to prevent it from becoming more complicated, and she would like to know if Professor Lundström would agree with that.

The Chairman opened the meeting for general discussion.

Mr. Robertson Ritchie said he had understood Professor Lundström to say that in the cases of asymmetry, in other words differences in width between molars of either side, it was likely to be due to non-genetic factors. Need that be necessarily so, since facial asymmetries could be inherited apparently?

Would Professor Lundström say that the conclusion from his findings was that the use of space-maintainers would not be necessary, or was that a misinterpretation of his feelings on the matter?

Mr. E. K. Breakspear said it was many years since Mr. Pringle had studied the effects of early loss on the overbite and overjet, and most people who had studied it since appeared to have come to the conclusion that it did not make very much difference. He was one of the people who were not satisfied that such was the case. He did not know at that moment whether it did or not, but he would like to point out some of the possibilities which might make the other results not quite so straightforward as might at first have appeared. He would be glad of Professor Lundström's comments.

He had a theory, which he had mentioned at the last meeting, that the effect of "double extraction" of deciduous teeth (i.e., extraction of two adjacent deciduous teeth) was different in kind from the effect of single extraction. He thought it was most important to separate the double from the single extractions, and not mix them up together. One of the things which could happen was that the tongue could get into a large space and act as a space retainer, but it could not get into a small space.

In Miss Clinch's cases which have been shown, he had noticed that where the upper D, E together had been extracted, the loss of space had not been nearly so great as it had been where the single D or the single E had been extracted. They had not been shown any cases of double extraction in the lower arch, and so had not been able to see if that had also applied at the bottom.

Professor Lundström had, however, shown the effect of bilateral lower deciduous extractions. He thought it was probable that when a number of such cases were taken it would be found that a large proportion of them had bilateral loss of all four D's and E's. He thought that was more common in the lower arch than in the upper, and it might affect the results and give an impression of fewer defects than might really be the case if they could be analysed. He also thought that if all the lower D's and E's were lost, some cases might have a collapse of the lower arch backwards and others might acquire an artificial, pre-normal occlusion. If all those things were to be lumped together in the same survey they might cancel each other out and give the impression that no harm was done. In actual fact they might each have a definite kind of harm in the opposite direction.

Was it possible that there was a difference between Swedish and British material? He had had the impression when in Sweden, that there were more pre-normal cases there than here. That might alter the apparent effect and he would like to have comments. He had enjoyed Professor Lundström's paper immensely, and thought it extremely valuable.

Mr. J. H. Hovell said he had been very interested in the paper. It showed how an eminent orthodontist from another country had possibly the same views as many orthodontists in this country.

The paper had indeed shown that the majority of malocclusions, as seen in orthodontic practice, were in fact a combination of a number of variations. He would cite the paper as putting another nail in the coffin of the "pathodontist" [Mr. Hovell's term for orthodontists who think malocclusions are due to pathological interference with growth] and leaving orthodontists to real orthodontic thinking.

Mr. Robertson Ritchie had raised one point on which he had been about to take issue. He thought the whole argument on the fact that two sides could not be a genetic variation was based on a false premise that the body was geometrically symmetrical. It was not, certainly in the thorax, abdomen, and pelvis. They could very well demonstrate the hereditary, unilateral asymmetries which could be present in teeth, and facial skeleton, and other minor details which were not really noticeable.

Mr. W. J. Tulley said the twin material from which Professor Lundström's paper had been derived was unique.

He had noted that the author had not commented on the soft tissues, which he had thought was very tactful.

Had Professor Lundström observed from his material any evidence of lisping in the speech of dizygotic, or uniovular twins, and had it occurred more frequently in the uniovular or the dizygotic twins?

Mr. R. E. Rix said that, as they had expected, the meeting had heard some very interesting facts.

While he would agree entirely that the extraction of the four first permanent molars left the overbite at long last about where it had been before, he felt that an impression might get around that one could take either the lower or the upper pair out and still leave the same degree of incisor overbite. He thought, however, that it could make a difference if one pair, say the lower pair, were extracted, leaving the other pair.

Would Professor Lundström please comment on that?

Professor Lundstrom, replying to the discussion, said he hoped he would be able to manage, in what was to him a foreign language, to answer the questions satisfactorily.

Miss Clinch had asked how surplus space was defined. It was merely a question of measuring the arch perimeter and then the sum of the tooth-breadths, and then the difference between the two. If the arch perimeter were larger than the sum of the tooth-breadths, the conclusion would be arrived at as it had been defined in the diagram. In the upper jaw the figures were reduced by 1 mm. as cases with even dental arches (no crowding or spacing) showed, on an average, a space-difference of +1 mm. in this jaw. He had to admit that that type of measuring might possibly be a little misleading. The errors, however, would be comparatively small and would not affect the general distribution much.

He had also been asked what was an excessive overbite, and of course he could not say where the dividing line was to be placed. He had mentioned in his paper the standards used by Seipel in a classification of overjet and overbite, but he thought perhaps one was apt to say that treatment should be considered with an excessive overbite at the level of 5 or 6 mm. It was very difficult to say. He had not wanted to take therapeutical problems into his paper.

He had also been asked why he had used deviations from the mean, and not as mentioned from the ideal occlusion. The reason was statistical, and it was a way of determining the standard deviation. What he had been interested in was the variability as such, and if the variability were due to genetic or non-genetic factors. In that case it would not really have been any advantage to use the ideal occlusion instead of the mean.

Regarding illness causing caries, and then extraction of deciduous teeth which cause malocclusion, he thought that might be a possibility. The ordinary children's diseases, however, were too short to have that effect really, but it was not something he had studied.

Miss Clinch had said that 90 per cent of the cases which she had had with finger-sucking could be dissuaded from the habit by a short talk. He would certainly congratulate her on her influence. He had himself had difficulties with many of these cases, but perhaps Swedish children were more stubborn than English children. (Laughter.)

Another question had been posed regarding the early treatment of crossbite in the finger-sucking cases. He would have thought it was an advantage to get in early, as Miss Clinch had suggested.

He thought it was extremely likely that a space would induce tongue-thrusting to some extent, but, on the other hand, the finding that most of the finger-sucking cases had not shown any difference in overjet—and he had not seen it in overbite either—had seemed to show that perhaps not too many of the cases were harmed from tongue-thrusting a bit after the finger-sucking. The extreme cases were not, of course, included in a study such as he had presented, and they were those which were seen by them as specialists, and there was surely that factor in some of the cases.

He had been asked whether the differences in tooth-size between left and right sides were not non-genetic but genetic. Of course there were genetic asymmetries, and it was very difficult to say definitely that the left–right differences observed could not be of that type. He would not like to be dogmatic about it, but on the other hand he found in the twins that the bilateral differences were not systematic in their nature. There were instances of the central incisor having the larger tooth on the right and, in the same case, the canine perhaps could be the opposite. There seemed to be a random distribution of the left–right differences over the teeth in the same case, and that he thought indicated that it was not a genetic question but a random variability.

Regarding the comparison of double and single extraction, as mentioned by Mr. Breakspear, he was unable to answer that fully because he had no good material at hand. There was some material, but he had not thought of it enough to investigate it especially. He did not believe that his material would show such a tendency as a general one which perhaps would not be expected because there were so many factors which came into effect of an extraction of deciduous teeth. There was, for instance, the general development of the arches. Miss Clinch had shown that that factor was one of some importance and it would therefore probably not be possible to get a universal indication of that type. It might very well, however, be a factor and he would be very interested to learn more about the findings which Mr. Breakspear would get in the studies which he was doing.

He had not taken soft tissue into his paper because he had not studied it. It was very difficult in twins to get any objective valuation of soft tissue and of habits. He had not, he was afraid, investigated the lisping tendency which was asked about.

Mr. Rix had said that extraction of 4 molars must be looked upon in another way as compared with the extraction of 2, especially in the lower. Mr. Rix of course was quite right.

The Chairman said that Professor Lundström had prepared his paper, as he did everything, with meticulous care. It must have been doubly difficult for him because it had been done in what was to him a foreign language.

It had been a model paper, and had cleared up a number of points which had been mere speculation before. The meeting was greatly indebted to Professor Lundström for coming.

On behalf of the meeting he would like to thank Professor Lundström for his paper and Miss Clinch for opening the discussion.

The Chairman then declared the meeting closed.

CRANIAL AND FACIAL MEASUREMENTS AND CORRELATIONS IN ARAN ISLAND CHILDREN

By **R. B. DOCKRELL**, M.A., M.B., B.Ch., M.Dent.Sc.

THE present investigation falls into two parts which are quite distinct except that the same material has been used in both. In the first part, it was wished to find out the variation in the different measurements and also the variation between different families. In order to do this, it was necessary to standardize the population for age and sex, and these essential corrections have given a sample within which one can draw firmer conclusions than would be possible were conditions less stabilized, but mean that comparisons between this investigation and others become more difficult. There have been many investigations into the degree of resemblance or variation to be found in families and usually these have taken the form of comparing the occlusion, certain measurements, angles, or tooth size of parents with those of children (Begg, 1932; Russell Marsh, 1933; Rubbrecht, 1939; Moore and Hughes, 1942; Snodgrasse, 1948; De Coster, 1952; Tulley, 1952; Curtner, 1953; Ikeda, 1953; Haralabakis, 1954; Stein, Kelley, and Wood, 1955; Asbell, 1957) or of comparing monovular or binovular twins (Bachrach and Young, 1927; Detlefson, 1928; Korkhaus, 1928 and 1930; Reif, 1928; Goldberg, 1929; Hohl, 1934; Martin, 1934; Lundström, 1948; Bonello, 1958).

In the second part of this investigation, the degree of correlation between the various measurements is considered without any reference to the inter-relationships of many of the children. In respect of this part, many investigations have been carried out which compare in some way with the present investigation (Smyth and Young, 1932; Fleming, 1933; Shepherd, Sholl, and Vizoso, 1949; Howells, 1951, 1952; Lindegård, 1953; Björk, 1955; Scott, 1955; Sarnås, 1956). Whilst many of these authors have been concerned mainly with the factors responsible for the correlations, rather than the size of the correlation coefficients, there has been a certain amount of overlapping with the present investigation where similar or comparable measurements were concerned.

MATERIAL

The material for the present investigation was collected as a result of two visits, three years apart, to the largest of the Aran Islands. The Aran islanders are a mixed population of farmers and fishermen, and the largest island has a population of approximately 1000. The historical researches of J. R. W. Goulden suggest that they are largely of English stock with more mixture of Irish stock from the mainland lately, and this is borne out by the research of Hackett and Folan (1958) into the blood groups of the islanders. They found frequencies which approximate more to the south of England than to the neighbouring parts of the mainland. The following measurements were made with a cranial callipers on the living subject:—

1. Auricle (midpoint on posterior surface of right tragus) to nasion (skin over junction of nasal bone and cartilage).
2. Auricle to superior alveolar point (anterior margin of the gum papilla between the upper central incisors).
3. Auricle to menton (most anterior point of chin in midline).
4. Head length (maximum length from glabella anteriorly to back of head).
5. Head width (maximum width over parietal bones).
6. Face width (maximum width over zygomatic bones).
7. Nasion to menton (lowest point of chin in midline).
8. Nasion to superior alveolar point.

In the present investigation, the measurements of 157 children, 86 males and 71 females, ranging in age from 6 to 14 years were used. The children came from 51 families and there

Given at the meeting held on December 8, 1958.

Table I.

Dimension	Error of Measurement (30 Individuals)	Error of Error (30 Individuals)	Mean	Error of Mean	Standard Deviation	Error of Standard Deviation	Coefficient of Relative Variation	Error of Coefficient of Relative Variation	Standard Deviation of Intrafamily Variation	Variance Ratio
Auricle to nasion	1·19	± 0·15	109·95	± 0·35	± 4·37	± 0·25	3·97	± 0·22	3·64	2·41
Auricle to superior alveolar point	1·53	± 0·20	107·35	± 0·34	± 4·24	± 0·24	3·95	± 0·22	3·44	2·68
Auricle to menton	2·14	± 0·28	118·34	± 0·42	± 5·25	± 0·30	4·44	± 0·25	4·49	2·15
Head length	1·93	± 0·25	180·04	± 0·57	± 7·20	± 0·41	3·99	± 0·23	5·91	2·54
Head width (Biparietal)	1·44	± 0·19	145·82	± 0·40	± 5·07	± 0·29	3·48	± 0·20	3·90	3·16
Face width (Bizygomatic)	1·38	± 0·18	122·49	± 0·37	± 4·68	± 0·26	3·82	± 0·22	3·97	2·24
Nasion to menton	1·35	± 0·17	98·26	± 0·44	± 5·48	± 0·31	5·58	± 0·31	4·49	2·54
Nasion to superior alveolar point	1·96	± 0·23	59·93	± 0·30	± 3·77	± 0·21	6·29	± 0·35	3·37	1·81
Formula	$\sigma_i = \sqrt{\left(\frac{\Sigma d^2}{2N}\right)}$ Where d equals the difference between 2 measurements on the same individual	$\sigma_{\sigma_i} = \frac{\sigma_i}{\sqrt{(2N)}}$	$\overline{X} = \frac{\Sigma X}{N}$	$\sigma_{\overline{x}} = \frac{\overline{X}}{\sqrt{(N)}}$	$\sigma = \sqrt{\left\{\frac{\Sigma(X_1 - \overline{X})^2}{N}\right\}}$	$\sigma_\sigma = \frac{\sigma}{\sqrt{2N}}$	$V = \frac{100\sigma}{\overline{X}}$	$\sigma_v = \frac{V}{\sqrt{2N}}$	$\sigma_w = \sqrt{\{\Sigma K(\overline{X} - \overline{X}_F)^2\}}$ Where K equals the number in any particular family and $\overline{X}_F$ equals the mean for that family	$\frac{\sigma_B{}^2/N_1}{\sigma_w{}^2/N_2}$ Where σ_w is the variance within the families and N_1 and N_2 the number of families and the number of children

was one family of 6 children, 2 families of 5 children, seventeen families of 4 children, 11 families of 3 children, and 20 families of 2 children. Because a previous investigation on the islanders (Dockrell, Clinch, and Scott, 1954) had shown significant age and sex differences, and because regression equations were available, the children were all brought to ten years of age (observed measurement $\pm$ difference in months from 10 years of age multiplied by the increment for that sex and for that measurement) and corrected for sex (observed measurement multiplied by $\frac{\bar{x}m+\bar{x}f}{2(\bar{x}m \text{ or } \bar{x}f)}$). These corrections of the observed measurements introduced a source of error and in order to minimize this only children whose ages lay between 6 and 14 years were used in the investigation so that the corrections for age were limited to a maximum of 4 years in any one individual. The figures of 10 years $\pm$ 4 years are quite arbitrary; the figure of 10 years representing an approximate mean age for the whole island sample and the figure of 4 years a compromise between letting the correction for age involve too great a part of the whole value for any child and the reduction of the numbers which a narrowing of the age limits involved. The restriction meant reducing the number of children in many families, but was felt to be essential. The assumption that any particular child is growing at the standard linear male or female rate is not warranted, but the error is probably small, and Smyth and Young (1932) found a good fit when straight lines were fitted to their 8–14-year-old material. The validity of applying regression equations which had been plotted on the whole population to a sample was tested and no significant difference was found between the means for the corrected sample and the whole. Double determinations to determine the error of measurement had been carried out on a series of 30 children. All measurements are given in millimetres.

FINDINGS

The results of the double determinations are shown (*Table I*, columns 1 and 2). These show errors ranging from 2·14 mm. for the auricle to menton measurement to 1·19 mm. for the auricle to nasion measurement. As the measurements were all made with the same cranial callipers by the same investigators, differences in the size of the error may be presumed to be due to the difficulty in locating some of the points on living children. The significance of the differences between the errors was tested (*Table II*). These show a significantly larger error for auricle to menton than for any other and a significantly smaller error for auricle to nasion than any other. As the point auricle is common to both, the difference between the errors must be due to the greater difficulty in locating the point menton anteriorly than the point nasion, and in this case is probably due to the difficulty in getting the children to keep their teeth in occlusion while the measurement is being made. In the same way, the error for nasion to superior alveolar point is significantly larger than that for nasion to menton and this must be due to the difficulty in locating the superior alveolar point vertically because it is also significantly larger than the error for auricle to superior alveolar point, which is fairly low. Head length has an error which is significantly larger than most of the others although it is significantly less than auricle to menton.

The mean, its error, the standard deviation, its error, the coefficient of relative variation and its error were then calculated (*Table I*, columns 3–8). It must be emphasized at this point that these figures for such a highly standardized sample of population have very little value in an absolute sense and their value lies more in the possibility of comparison between the figures for the various measurements than in a comparison with the figures for other populations. It is, however, of interest to note how closely they approximate to other workers' figures for London children (Smyth and Young, 1932; Fleming, 1933). Where the measuring points are similar, the means and standard deviations are very close, and even where the points are different, the coefficients of relative variation are close. The only exception to this lies in the measurements

nasion to superior alveolar point and face width where a genuine sample difference is likely. *Table I*, column 5, shows that, of the three radial measurements, both auricle to nasion and auricle to superior alveolar point have very similar standard deviations, that for auricle to superior alveolar point being smaller. Smyth and Young's findings are similar for these three measurements although they measured from the transmeatal axis posteriorly, but in their case the standard deviation of transmeatal axis to nasion is less than that of transmeatal axis to upper incisor incisal edge. The significance of the differences between the standard deviations was also tested (*Table III*). This shows head length to have a significantly greater deviation than any other measurement, and nasion to superior alveolar point to have a significantly smaller one than any other apart from auricle to nasion and auricle to superior alveolar point. *Table I*, column 7, shows the coefficients of relative variation. These show that although head length has the largest deviation, its deviation relative to its size is not as high as that of auricle to menton, nasion to menton, nor nasion to superior alveolar point which, although it has the smallest standard deviation, is the most variable relative to its size. This latter was also Smyth and Young's finding. Once again there is a tendency for the three radial measurements auricle to nasion, auricle to superior alveolar point, and auricle to menton to group themselves together with similar figures and as before auricle to nasion and auricle to superior alveolar point do not differ significantly from one another while auricle to menton has a significantly higher standard deviation. In the same way there is a tendency for head width and face width to have similar deviations and coefficients of variation. The intrafamily and the interfamily variances were then calculated and the variance ratios obtained (*Table I*, column 10). Lundström (1948) working on monovular and binovular twins considered certain dental measurements and estimations, and found quotients for $\frac{\text{genetic factors}}{\text{non-genetic factors}}$ varying from 2·8 for arch width in the first premolar region to 0·8 for sagittal occlusion at the 1st permanent molar. In a later paper (1954) he measured certain angles on lateral cephalograms and found values for the same quotient varying from 1 to 2. Dockrell (1956) calculated the intrafamily and interfamily variance ratios for the size of certain teeth and found values ranging from 6·8 to 1·2. The values in the present investigation lie within the ranges of those for the permanent incisors and molars and the deciduous incisors and canines, and all are significant at the 5 per cent level. A high quotient for any particular measurement shows that the measurement is tending to be more alike in brothers and sisters than its overall variance justifies, and in this case head width is showing the greatest similarity followed by auricle to superior alveolar point and head length. The overall variance is made up of the intrafamily variance and the interfamily variance divided in accordance with the ratio given, and from these figures the standard deviation for the intrafamily variation can be obtained (*Table I*, column 9). The significance between the differences in the intrafamily standard deviations was then tested (*Table IV*). The significance of the differences between the overall standard deviations in *Table III* and between the intrafamily standard deviations in *Table IV* can be compared with one another and both deviations can be compared with the related variance ratio (*Table I*, columns 5, 9, and 10). When the tables are compared it can be seen that the order is similar in *Tables III* and *IV* except that head width, which had a larger overall deviation than face width, has a smaller intrafamily deviation than it. Although the difference between the two measurements is not significant in either table, this has had the effect of increasing the variance ratio for head width so that it is the highest investigated. Fewer of the differences between the deviations achieve significance in *Table IV* than in *Table III* as one would expect with the smaller numbers.

In the second part of the investigation, the correlation coefficients between the various dimensions were calculated and the results are given (*Table V*). There was no reason why

the figures for sueh inter-related ehildren should have been used in this section, and it is possible that these relationships may have altered the correlation coeffieients to a significant degree although the general similarity of the findings to those of other workers do not suggest heavily loaded figures. There was a good reason for using figures which had been standardized for age and sex beeause the different rates and times of growth for the

Table II.—Significant Differences between the Errors of Measurement at the 5 per cent Level

Dimension	Auricle to Menton (2·14)	Nasion to Superior Alveolar Point (1·96)	Head Length (1·93)	Auricle to Superior Alveolar Point (1·53)	Head Width (1·44)	Face Width (1·38)	Nasion to Menton (1·35)
Auricle to Nasion (1·19)	S	S	S	S	S	S	S
Nasion to Menton (1·35)	S	S	S	S	NS	NS	
Face Width (1·38)	S	S	S	S	NS		
Head Width (1·44)	S	S	S	NS			
Auricle to Superior Alveolar Point (1·53)	S	S	S				
Head Length (1·93)	S	NS					
Nasion to Superior Alveolar Point (1·96)	S						

Dimensions are arranged in descending order of the size of the error horizontally aeross the top and in ascending order vertically on the left. Therefore column 1 vertically gives the dimensions which have a smaller error than auricle to menton and column 6 vertically the dimensions which have a smaller error than face width. In the same way, column 3 horizontally gives the dimensions which have a larger error than face width. The letters "S" or "NS" indicate whether the difference between the errors is significant or not at the 5 per cent level.

Table III.—Significant Differences between the Standard Deviations of the Mean at the 5 per cent Level

Dimension	Head Length (7·20)	Nasion to Menton (5·48)	Auricle to Menton (5·25)	Head Width (5·07)	Face Width (4·68)	Auricle to Nasion (4·37)	Auricle to Superior Alveolar Point (4·24)
Nasion to Superior Alveolar Point (3·77)	S	S	S	S	S	NS	NS
Auricle to Superior Alveolar Point (4·24)	S	S	S	S	NS	NS	
Auricle to Nasion (4·37)	S	S	S	NS	NS		
Face Width (4·68)	S	S	NS	NS			
Head Width (5·07)	S	NS	NS				
Auricle to Menton (5·25)	S	NS					
Nasion to Menton (5·48)	S						

See footnote, *Table II.*

different dimensions must alter the correlations and it is apparent that correlation coefficients should be considered as related to a certain age and sex group rather than as absolutes. These figures should be considered as relating to a highly standardized 10-year-old population and the possibility of loading due to blood-ties kept in mind. The values are all positive and their significance was tested at the 5 per cent level, light type indicating a

Table IV.—Significant Differences between the Intrafamily Standard Deviations at the 5 per cent Level

Dimension	Head Length (5·91)	Nasion to Menton (4·49)	Auricle to Menton (4·49)	Face Width (3·97)	Head Width (3·90)	Auricle to Nasion (3·64)	Auricle to Superior Alveolar Point (3·44)
Nasion to Superior Alveolar Point (3·37)	S	S	S	NS	NS	NS	NS
Auricle to Superior Alveolar Point (3·44)	S	S	S	NS	NS	NS	
Auricle to Nasion (3·64)	S	S	S	NS	NS		
Head Width (3·90)	S	NS	NS	NS			
Face Width (3·97)	S	NS	NS				
Auricle to Menton (4·49)	S	NS					
Nasion to Menton (4·49)	S						

See footnote, *Table II.*

Table V.—Correlation Coefficients and their Significance at the 5 per cent Level

Dimension	Nasion to Superior Alveolar Point	Nasion to Menton	Face Width	Head Width	Head Length	Auricle to Menton	Auricle to Superior Alveolar Point
Auricle to Nasion	0·372	0·504	0·458	0·215	0·477	0·534	0·690
Auricle to Superior Alveolar Point	0·363	0·703	0·462	0·190	0·384	0·721	
Auricle to Menton	0·258	0·443	0·511	**0·110**	0·284		
Head Length	0·330	0·417	0·194	**0·090**			
Head Width	**0·018**	**0·135**	0·383				
Face Width	0·237	0·354					
Nasion to Menton	0·667						

All values are positive. Light type figures are significant. Heavy type figures are not significant.

Correlation coefficient $r = \dfrac{\Sigma(x_1-\bar{x})(y_1-\bar{y})}{N\sigma_x \quad \sigma_y}$

Significance tested at 5 per cent level by t test $\left(t = \dfrac{r}{\sqrt{(1-r^2)}}\sqrt{(N-2)}\right)$

If $t > 1{\cdot}96$ the correlation is considered significant.

significant correlation and heavy type the lack of a significant correlation. All the dimensions show significant correlations with one another apart from head width, which measurements, auricle to nasion, auricle to superior alveolar point, and auricle to menton, show high correlations with one another, slightly lower correlations with nasion to

Table VI.—Significance of Differences between the Correlation Coefficients for the Dimension Auricle to Nasion at the 5 per cent Level

Auricle to Nasion and	Auricle to Superior Alveolar Point (0·690)	Auricle to Menton (0·534)	Nasion to Menton (0·504)	Head Length (0·477)	Face Width (0·458)	Nasion to Superior Alveolar Point (0·372)
Head Width (0·215)	S	S	S	NS	NS	NS
Nasion to Superior Alveolar Point (0·372)	S	NS	NS	NS	NS	
Face Width (0·458)	S	NS	NS	NS		
Head Length (0·477)	S	NS	NS			
Nasion to Menton (0·504)	NS	NS				
Auricle to Menton (0·534)	NS					

See footnote, *Table II.*

Table VII.—Significance of Differences between the Correlation Coefficients for the Dimension Auricle to Superior Alveolar Point at the 5 per cent Level

Auricle to Superior Alveolar Point and	Auricle to Menton (0·721)	Nasion to Menton (0·703)	Auricle to Nasion (0·690)	Face Width (0·462)	Head Length (0·384)	Nasion to Superior Alveolar Point (0·363)
Head Width (0·190)	S	S	S	NS	NS	NS
Nasion to Superior Alveolar Point (0·363)	S	S	S	NS	NS	
Head Length (0·384)	S	S	S	NS		
Face Width (0·462)	S	S	S			
Auricle to Nasion (0·690)	NS	NS				
Nasion to Menton (0·703)	NS					

See footnote, *Table II.*

shows low correlations: head width/nasion to superior alveolar point, head width/nasion to menton, head width/auriele to menton, and head width/head length, failing to achieve significant correlations, as does head length/face width. Again there is a grouping of the figures as one would expect. The three radial menton, still lower with face width and head length, and least with head width. Head length has generally low correlations which are not significant with head width and face width. Nasion to menton has higher correlations with the other dimensions than has nasion to superior alveolar point and the two show a

high correlation with one another. Where the measuring points are similar, there is fairly close agreement with the figures of Smyth and Young and Fleming, and especially with their menton are close to theirs. The pattern is the same in that auricle to superior alveolar point/auricle to menton has a higher correlation than auricle to nasion/auricle to superior alveolar

Table VIII.—Significance of Differences between the Correlation Coefficients for the Dimension Auricle to Menton at the 5 per cent Level

Auricle to Menton and	Auricle to Superior Alveolar Point (0·721)	Auricle to Nasion (0·534)	Face Width (0·511)	Nasion to Menton (0·443)	Head Length (0·284)	Nasion to Superior Alveolar Point (0·258)
Head Width (0·110)	S	S	S	S	NS	NS
Nasion to Superior Alveolar Point (0·258)	S	S	NS	NS	NS	
Head Length (0·284)	S	NS	NS	NS		
Nasion to Menton (0·443)	S	NS	NS			
Face Width (0·511)	S	NS				
Auricle to Nasion (0·534)	S					

See footnote, *Table II.*

Table IX.—Significance of Differences between the Correlation Coefficients for the Dimension Head Length at the 5 per cent Level

Head Length and	Auricle to Nasion (0·477)	Nasion to Menton (0·417)	Auricle to Superior Alveolar Point (0·384)	Nasion to Superior Alveolar Point (0·330)	Auricle to Menton (0·284)	Face Width (0·194)
Head Width (0·090)	S	S	S	NS	NS	NS
Face Width (0·194)	S	S	S	NS	NS	
Auricle to Menton (0·284)	NS	NS	NS	NS		
Nasion to Superior Alveolar Point (0·330)	NS	NS	NS			
Auricle to Superior Alveolar Point (0·384)	NS	NS				
Nasion to Menton (0·417)	NS					

See footnote, *Table II.*

first order partial correlations when age is constant. In the present investigation the values for auricle to nasion/auricle to superior alveolar point and for auricle to nasion/auricle to menton fall between the male and female values of Smyth and Young, and those for auricle to superior alveolar point/auricle to point and this is higher than auricle to nasion/auricle to menton. In the same way the low correlation of head width/head length, which fails to achieve significance, is in agreement with Fleming's first order partials when age is constant. Comparisons with other investigators using material of differing ages

is more difficult, but both Howells (1951, 1952) and Lindegård (1953) agree in finding higher coefficients studied than between head width and the others. Howells, analysing a number in the correlations between the various cranial, facial, and dental measurements than in the correlations between these measurements and length or sturdiness factors, in measurements

Table X.—Significance of Differences between the Correlation Coefficients for the Dimension Head Width at the 5 per cent Level

Head Width and	Face Width (0·383)	Auricle to Nasion (0·215)	Auricle to Superior Alveolar Point (0·190)	Nasion to M nton (0·135)	Auricle to Menton (0·110)	Head Length (0·090)
Nasion to Superior Alveolar Point (0·018)	S	NS	NS	NS	NS	NS
Head Length (0·090)	S	NS	NS	NS	NS	
Auricle to Menton (0·110)	NS	NS	NS	NS		
Nasion to Menton (0·135)	NS	NS	NS			
Auricle to Superior Alveolar Point (0·190)	NS	NS				
Auricle to Nasion (0·215)	NS					

See footnote, *Table II.*

Table XI.—Significance of Differences between the Correlation Coefficients for the Dimension Face Width at the 5 per cent Level

Face Width and	Auricle to Menton (0·511)	Auricle to Superior Alveolar Point (0·462)	Auricle to Nasion (0·458)	Head Width (0·383)	Nasion to Menton (0·354)	Nasion to Superior Alveolar Point (0·237)
Head Length (0·194)	S	NS	NS	NS	NS	NS
Nasion to Superior Alveolar Point (0·237)	S	NS	NS	NS	NS	
Nasion to Menton (0·354)	NS	NS	NS	NS		
Head Width (0·383)	NS	NS	NS			
Auricle to Nasion (0·458)	NS	NS				
Auricle to Superior Alveolar Point (0·462)	NS					

See footnote, *Table II.*

of factors to determine their influence on the coefficients, found significantly positive correlations between most of the comparable dimensions apart from head width. The pattern of his findings is similar to the present investigation although the individual coefficients vary. Lindegård, who was less interested on living subjects, found head length/head width, head length/face width, and head length/auricle to menton to have significant positive correlations and auricle to menton/face width to lack significance. The greatest disagreement in the findings concerns two coefficients: head length/head width which

Howells and Lindegård found to have a significant correlation whereas Fleming and the present investigation did not, and face width/auricle to menton which Howells and the present investigation found to have a significant correlation whereas Lindegård did not. great, the significant coefficients being only just so and the non-significant ones only just failing to reach the level of significance.

The significance of the differences between the various correlation coefficients were also tested (*Tables VI–XIII*). It is interesting to

Table XII.—Significance of Differences between the Correlation Coefficients for the Dimension Nasion to Menton at the 5 per cent Level

Nasion to Menton and	Auricle to Superior Alveolar Point (0·703)	Nasion to Superior Alveolar Point (0·667)	Auricle to Nasion (0·504)	Auricle to Menton (0·443)	Head Length (0·417)	Face Width (0·354)
Head Width (0·135)	S	S	S	NS	NS	NS
Face Width (0·354)	S	S	NS	NS	NS	
Head Length (0·417)	S	S	NS	NS		
Auricle to Menton (0·443)	S	S	NS			
Auricle to Nasion (0·504)	S	NS				
Nasion to Superior Alveolar Point (0·667)	NS					

See footnote, *Table II.*

Table XIII.—Significance of Differences between the Correlation Coefficients for the Dimension Nasion to Superior Alveolar Point at the 5 per cent Level

Nasion to Superior Alveolar Point and	Nasion to Menton (0·667)	Auricle to Nasion (0·372)	Auricle to Superior Alveolar Point (0·363)	Head Length (0·330)	Auricle to Menton (0·258)	Face Width (0·237)
Head Width (0·018)	S	S	S	S	NS	NS
Face Width (0·237)	S	NS	NS	NS	NS	
Auricle to Menton (0·258)	S	NS	NS	NS		
Head Length (0·330)	S	NS	NS			
Auricle to Superior Alveolar Point (0·363)	S	NS				
Auricle to Nasion (0·372)	S					

See footnote, *Table II.*

An examination of the actual figures, however, does much to explain the contradictory findings because one finds that where a correlation coefficient achieves significance in one investigation and fails to do so in another, the real difference between the figures is not usually note that the dimension auricle to superior alveolar point has higher correlation coefficients than any other and that its coefficients show more significant differences between one another than do those of any other dimension. It is easier to demonstrate significant

differences in a dimension which has a very wide range of values for the coefficients or in one which shows many high values and many low ones, i.e., a grouping of the coefficients at both ends of the scale. In the case of auricle to superior alveolar point there does not seem to be a wider scale and the explanation seems to lie in the grouping into three high coefficients separated by a wide gap from the four others. Despite, therefore, its large number of significant differences, the dimension auricle to superior alveolar point can in this material lay claim to be the central dimension of those studied.

There is one finding above all others in this investigation which appears suggestive and which is being singled out for special discussion. The dimension auricle to superior alveolar point has a smaller overall deviation and intrafamily deviation than auricle to nasion. Although these differences are not significant, they are surprising in view of the fact that the superior alveolar point is usually believed to be an unreliable point anteroposteriorly since it is so modified by "local" or "non-genetic factors", whereas the nasion is believed to be free from them. In addition, the superior alveolar point is believed to be affected by the muscles of the lips and tongue whereas the nasion is free from muscular influences. In view of these factors which are affecting only one of the points, one would expect a larger variation in the superior alveolar point rather than a smaller one. If there were a larger variation in the dimension auricle to superior alveolar point than in auricle to nasion, one could look whether it lay in the interfamily variance, suggesting a genetic or familial cause and raising the numerator and therefore the ratio, or partly familial and partly chance keeping the ratio the same, or completely in the intrafamily variance suggesting chance factors raising the denominator and decreasing the ratio.

It is possible that some of these "local" factors, e.g., habits, etc., have a genetic cause and that muscular behaviour is genetically determined as has been stated by Ballard (1954) and this would account for the higher variance ratio of auricle to superior alveolar point, but the rise is small, is not significant, and one must assume that the contribution of these causes is equally small and insignificant and that the lack of a rise in the overall variation is against a marked effect from these causes. In this investigation the superior alveolar point appears to be as stable a point anteroposteriorly as nasion, despite the many factors which may be influencing it, and the correlation coefficients are contributory evidence of the relative stability of this dimension and of the anteroposterior position of the superior alveolar point itself. If this point were being affected to a marked degree by chance factors which are not affecting the other points, then its correlation coefficients should be lower than those of the other dimensions. The fact that they are higher means that it would seem advisable to await more evidence before attributing marked effects on the anteroposterior position of this point to local, dental, or muscular influences.

SUMMARY

1. Eight cranial and facial measurements in each of a group of 157 children lying in 51 families have been reduced to a common age and sex.

2. The mean, the overall standard deviation, the intrafamily standard deviation, the coefficient of relative variation, the interfamily and intrafamily variance ratio, and the correlation coefficients were calculated for each dimension.

3. All the variance ratios were significant at the 5 per cent level.

4. Apart from the dimension head width, all the correlation coefficients between all the dimensions were significant at the 5 per cent level.

5. In view of the lack of a significantly higher standard deviation, coefficient of relative variation, and standard deviation of intrafamily variation of the dimension auricle to superior alveolar point, when compared with auricle to nasion, and in view of its high correlation coefficients, it is questioned whether, in this sample, local, dental, or muscular forces can have had any marked

effect on the anteroposterior position of the superior alveolar point.

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DISCUSSION

Mr. Mills, opening the discussion, congratulated Dr. Dockrell on a most painstaking and thorough piece of research. It would form a standard reference in our transactions for other workers on a borderline of orthodontics and physical anthropology.

The paper, as written, would probably be difficult for the average orthodontist to understand, without a knowledge of statistics. In delivering it, Dr. Dockrell had made the way plain and explained the statistical technicalities in a masterly fashion.

Dr. Dockrell has suggested that the findings would indicate that the soft tissues had little effect on the position of the incisor teeth. Mr. Mills could not altogether agree with this. Several others have shown that where a skeletal abnormality existed this usually lay in the position of the mandible. Downs's "point B" was usually placed posteriorly or anteriorly to "point A". These points, however, would not be affected by the lips and tongue. The effect of the muscles would be to tilt the teeth. This would not materially affect the position of the interdental septum between $\underline{1|1}$ which was the point from which Dr. Dockrell had measured.

Björk had shown that while overjet in extreme Class II, division 1 cases was the usual result of the skeletal pattern, nevertheless, it could be increased by adverse tipping of the teeth or decreased by a favourable tilting. It was difficult to explain this tipping on any grounds other than that of the surrounding soft tissues.

He was very interested in Dr. Dockrell's finding of the importance of genetic factors in determining the skeletal pattern. This confirmed the findings in several other recent investigations. He wondered whether in fact the situation was more marked than would at first sight appear, since many individuals in Aran who were apparently unrelated would probably have some blood-ties owing to

the smallness of the community. Would Dr. Dockrell agree that this was the case?

Dr. Dockrell, in reply, thanked the members for the reception they had given to the paper. It was a privilege to be permitted to address the Society at any time, and an even greater one to do so in the Jubilee Year. In particular, he would like to thank Mr. Mills for his kind remarks and to deal with some of his questions. Mr. Mills had taken him up about the stability of the superior alveolar point. First of all, he must make it quite clear that he had no information about either the angulation of the incisors or the position of the mandible. Both of them were outside the scope of the paper. With regard to the position of the incisor teeth, he had no evidence except in so far as the superior alveolar point offered an indication of the position of the uppers, and all he could say then with any degree of certainty was that if the local factors were tilting the incisors markedly, then the centre of rotation must be close to the superior alveolar point and that Smyth and Young had measured to the incisal edge of the upper incisors with similar results to his. Mr. Mills had referred to his findings about the "importance of genetic factors" and he would like to repudiate any such suggestion. It was very likely that genetic factors did play an important part, but an experiment such as his could demonstrate only familial factors and to ascribe these factors to specific causes was to go beyond his evidence. In fact, he had used the term "genetic" rarely in the paper, and then with reluctance, because he believed it to have a precision which was not equalled by most present methods of investigation. It was, perhaps, possible to apply it to a difference between the findings for monovular and binovular twins, provided one was quite satisfied about the method for assessing the number of ova, but beyond that he felt the term should be used with great caution. With regard to the question about the blood-ties, it was quite true that many of the children were cousins of one another, but he was not sure about the actual effect of this on the findings. In theory, it ought, by limiting the range, to decrease the effect as Mr. Mills had said but, in fact, it need not have done so to a marked degree, and it would be better to wait for the results of an investigation into that problem they had carried out that summer on Aran. Once again he would like to thank Mr. Mills very much for all the trouble he had taken to make his points clear, for his complimentary remarks, and the audience for their attention.

Mr. A. G. Taylor said the meeting had been privileged occasionally to have papers on what might be called physical anthropology. He thought this had been the first paper which had dealt with the British Isles. Nearly all the previous papers had begun with a description of the subjects and their method of life. When one knew in advance the subject of a proposed paper, an opportunity was given to read up literature beforehand. He had, therefore, asked some of his Irish friends what they knew about the Aran Islands. Instead of, as he had expected, being told that the Islands were of a mixed population he had learnt that in recent years they had been a very isolated population. It was thought, however, that there was quite a lot of Spanish blood there, but whether the Spaniards were Celts or whether the Aran Islanders were Celts he really was not quite sure. Irish was, however, spoken there, and he understood that those wishing to obtain posts in the Irish universities were in the habit of going to the Aran Islands to improve their Irish.

He understood that islands had another peculiarity. They had an effect on the people who lived there or visited them. It was a very strange effect, and he thought that Mr. O'Flaherty, who had gone there to make one of the most outstanding films ever produced, might have perhaps felt its influence. A similar effect had appeared to be shown by the works of authors and playwrights, and he wondered if there was an influence cast upon those who visited the Aran Islands.

Dr. Dockrell had said that the people in London were very similar to those in the Aran Islands as regards the deviations, when one came to measurements, in members of the same family. Why did he go to the Aran Islands to get his measurements?

As a preliminary to their papers, authors generally explained how they obtained their measurements. Dr. Dockrell had not explained this; he had said there were perhaps deviations and errors in making the measurements, and, therefore, a fortnight later a check was made in order to ensure the accuracy of the figures. Were the same people taking the measurements, and were they using the same instruments? This was of importance in making statistical analyses.

As regards the statistics in the paper, these were generally difficult until set down in print. He felt sure that it would then prove even more valuable, but it was difficult to discuss the figures which had been presented verbally. One question he would like to raise was why the standard deviation should have error.

Dr. Dockrell thanked Mr. Taylor for his remarks, and said he had had the feeling before the meeting that in whichever form he read the paper he would regret that he had not read the other form. (Laughter.)

He had omitted reference to the method of taking measurements because that had been given in some detail in the *European Orthodontic Society Transactions*, 1954, including notes on the children's diet, etc. The measurements had been made with callipers on the moving children, as it were, and the measurements made a week later were made on the same children by the same operators, with the same instruments. The errors were calculated later.

As to why he had gone to Inishmore in the first place, Miss Clinch or Dr. Scott could tell as much as he could because they had both been there, too. It had seemed reasonable to assume that a small island would be very inbred, and that interesting findings might turn up, due to the appearance of genetic drift. In actual fact, by the time they had gone to the island, they had learnt enough to make it clear that the population was not extremely inbred or, if it were, that that had happened only recently. On other grounds, the island was ideal in that the population was of the right size for their resources, is not subject to migration at school-age, and despite its isolation, is quite accessible.

The question of Spanish blood, of course, was a difficult one. Galway had been a big port in the Middle Ages and as the three Aran Islands blocked the approaches to Galway they had been a nest of pirates. The result was that there were always garrisons on the Islands—Elizabethan garrisons, Williamite garrisons, Jacobite garrisons—largely keeping the people quiet. He did not know how much Spanish blood was in the population, but at least the Spaniards did not seem to have left their names. On the other hand, the English had, and this sense of honour, if he might so call it, had its effect on the islanders' names. The names of the islanders in 1821 revealed an enormous number of what

might be called English, or at least non-Irish surnames, each with very few representatives—that is, one family or perhaps two of a particular name. A change appeared to have taken place since then, in that many of these surnames had died out and had been replaced by numerically fewer Irish surnames most of which were common to a much larger number of families.

With regard to the question about standard deviation and its error, just to make things difficult, of course, the standard deviation was often called the standard error of the mean. He had put in the error of the standard deviation as an index of where the true standard deviation might be for a larger population, just as he had put in an indication of where the true mean for a larger population or the true error of measurement might lie.

The standard deviation for these children might be of little interest in itself and more use might be made of its applicability to a larger population. Assuming a normal distribution, the error of the standard deviation could be used to give the probability of the standard deviation for the larger population's lying within a certain distance of that of these children.

SURGERY IN RELATION TO THE DEVELOPING DENTITION

By **R. W. WILLCOCKS**, B.D.S., F.D.S., R.C.S.
*Guy's Hospital, London, S.E.*1

CASE histories, radiographs, models, and slides of patients treated in the Children's Department, Guy's Hospital, were shown. These cases combined both surgery and orthodontic treatment, the surgical procedures being carried out under general anæsthesia in most cases.

Fig. 1.—Failure of eruption of $\underline{1|1}$ due to the presence of two palatal supernumeraries.

Fig. 2.—Median diastema and displacement of $\underline{1|}$ due to a supernumerary.

Fig. 3.—Midline supernumerary.

1. Supernumeraries in the Palate.—The presenting symptoms in the cases shown were either failure of eruption of one or both maxillary central incisors (*Fig.* 1) or the presence of a median diastema (*Figs.* 2, 3). The radiographic appearance of these cases varied from a small denticle or a single midline conical supernumerary to the bilateral and tubercular types of supernumeraries (*Figs.* 4, 5, and 6).

Surgical Technique.—Unerupted, supernumerary teeth in the palate are most commonly situated on the palatal side of the permanent maxillary incisors. Thus a palatal approach is made with reflection of the mucosa and careful removal of overlying bone. In favourable cases the crown of unerupted maxillary central incisors should be uncovered. Extractions are frequently indicated in order to create space for the unerupted teeth and these extractions should, if possible, be carried out at operation and not left until a later date, provided prognosis for the eruption of delayed teeth is favourable.

Orthodontic treatment following surgery is necessary to erect and maintain sufficient space for the unerupted permanent teeth in the first instance. Later, alignment of these teeth may be necessary, using fixed or removable appliances. This plan of treatment is well illustrated in *Fig.* 7.

A demonstration given at the Jubilee Meeting held on May 10, 1958.

2. Supernumeraries under Observation.—The mere presence of an unerupted supernumerary tooth in the palate as seen on a routine standard occlusal radiograph is no indication for the immediate surgical removal of this tooth. Cases were shown (*Figs.* 8, 9) where although an extra tooth was present, there was no malalinement of the adjacent permanent teeth. These cases, however, are kept under observation and periodic X-rays are taken to watch for cyst formation or resorption of adjacent roots of permanent teeth.

Fig. 4.—Small denticle preventing eruption of $\underline{|1}$.

Fig. 5.—Inverted supernumerary displacing $\underline{1|}$ and causing diastema.

Fig. 6.—Bilateral tuberculated supernumeraries.

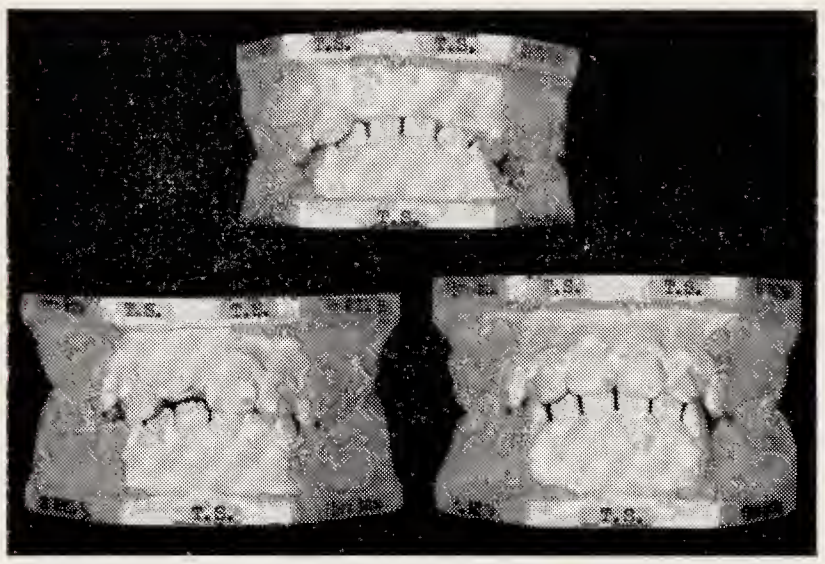


Fig. 7.—$\underline{1|1}$ delayed by supernumerarics. After surgical removal $\underline{|2}$ was moved over the bite. Space for $\underline{1|1}$ was recreated and incisors alined with Johnson twin arch.

Fig. 8.—Unerupted supernumerary. No symptoms.

3. Geminated Composite Odontomes.—Whilst gemination between two teeth of the normal series in the incisor region in the deciduous dentition is relatively common, it is rare to find three teeth involved, namely $\underline{|ABC}$ as illustrated in *Figs.* 10, 11. This odontome was removed due to pulpitis resulting from the extension of caries in a palatal fissure.

4. Dilacerated Maxillary Central Incisors.—Trauma to the maxillary incisor region at an

Fig. 9.—Unerupted supernumerary. No symptoms.

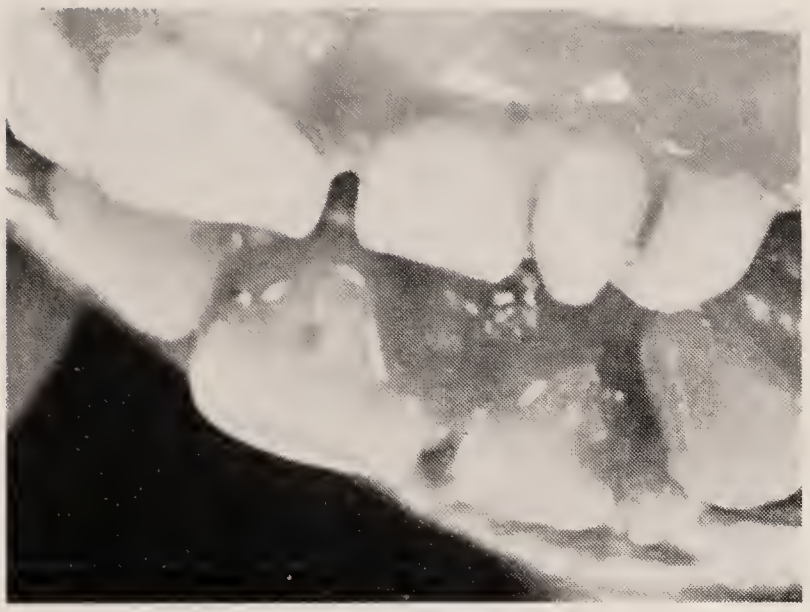


Fig. 10.—Gemination of |ABC.

early age if transmitted to a developing permanent incisor may lead to varying degrees of dilaceration of the crown or root. Whilst minor dilaceration of the crown of the tooth is rarely sufficient to prevent its eruption and may be successfully treated at a later date by conservative methods, dilaceration of the root not infrequently leads to failure of eruption (*Figs.* 12, 13).

At operation, these teeth are commonly removed by the labial approach, the difficulty of removal increasing as the angle decreases

Fig. 12.—Unerupted and dilacerated 1|.

between the long axis of the two sections of the root.

Subsequent orthodontic treatment will depend on the particular arch relationship and the size of the teeth in relation to arch size.

5. Dentigerous Cysts.—In children, dentigerous cysts may occur in association with the

Fig. 11.—Gemination of |ABC (palatal aspect).

unerupted maxillary canine or supernumerary tooth in the palate and unerupted premolars. They may present in varying stages from an incidental radiographic finding to an obvious facial swelling. They are rarely infected.

The case shown exhibited marked facial asymmetry and radiographic examination

Fig. 13.—Dilaceration of root 1|.

revealed two unerupted supernumerary teeth in the palate, together with a dentigerous cyst associated with one of these supernumeraries (*Fig.* 14). At operation the dentigerous cyst was first aspirated and then opened into the labial sulcus. The two supernumerary teeth were removed together with the cyst lining and the cavity packed.

Fig. 14.—Dentigerous cyst associated with an unerupted supernumerary.

Following operation the unerupted $\underline{1}|$ soon appeared in the oral cavity, but with a marked palatal and lateral inclination (*Fig.* 15). Orthodontic treatment using a simple

Fig. 15.—Post-operative condition, showing position of $\underline{1}|$.

removable appliance with a palatal spring is now required to aline $\underline{1}|$ and possibly $\underline{2}|$ on eruption.

6. Compound and Complex Composite Odontomes.—Failure of eruption of a maxillary central incisor may be due not only to the presence of a supernumerary tooth but

Fig. 16.—Compound composite odontome displacing $\underline{1}|$.

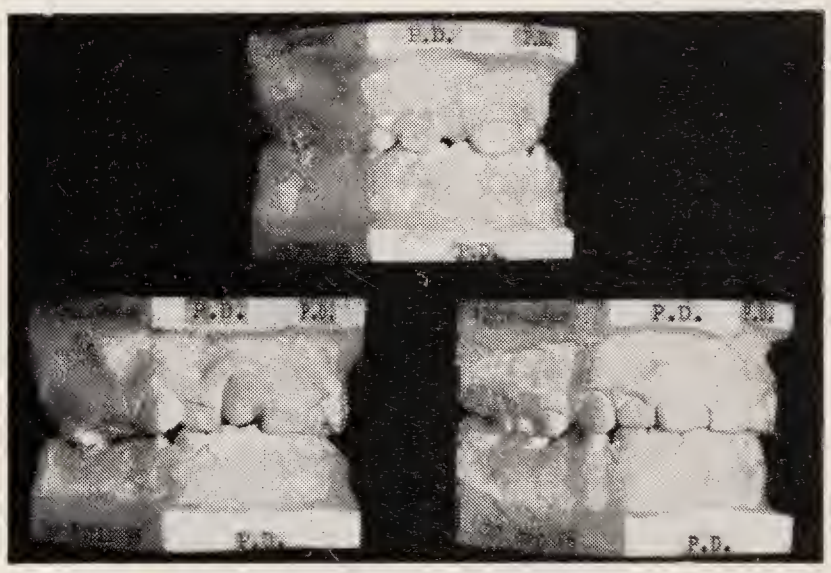
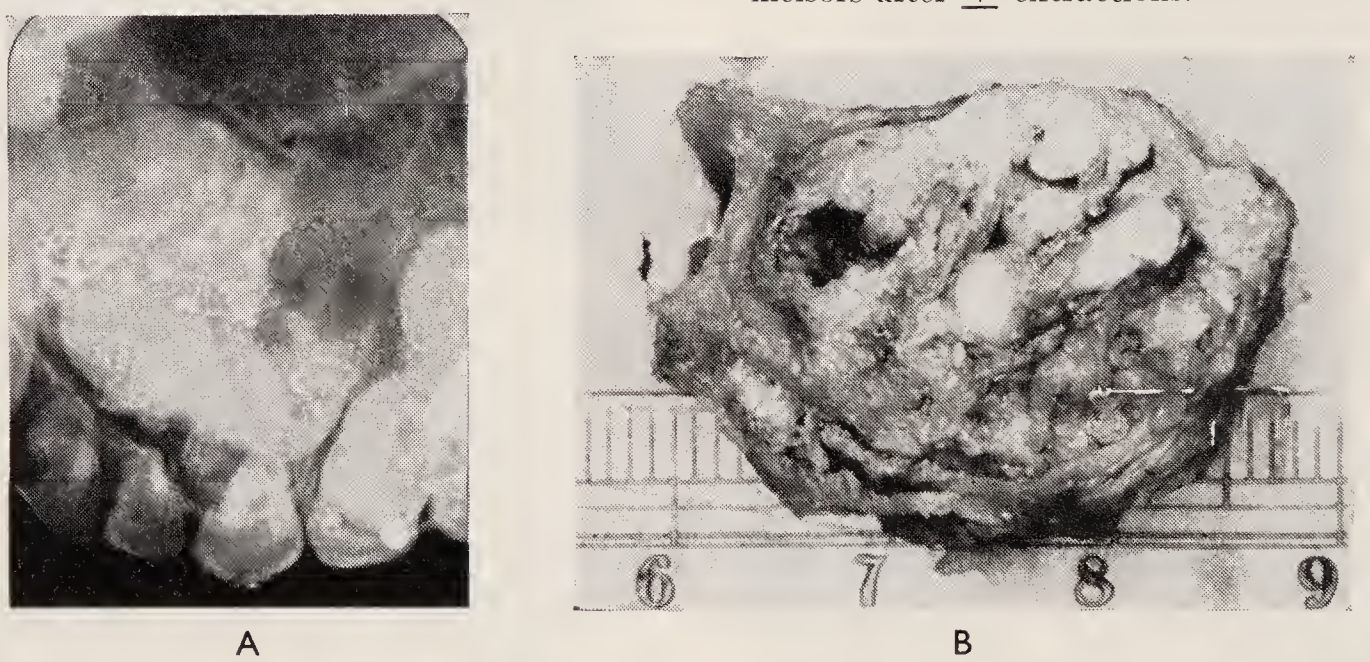


Fig. 17.—Model of case in *Fig.* 16, showing eruption of $\underline{1}|$ following removal of odontome and alinement of incisors after $\underline{4|4}$ extractions.



A B

Fig. 18.—A, X-ray showing large complex composite odontome; B, Complex composite odontome after removal.

occasionally to the presence of a compound or complex composite odontome.

In *Fig.* 16 the occlusal radiograph shows a compound composite odontome displacing and preventing the eruption of 1|. At operation these denticles were removed by a labial approach. Subsequent orthodontic treatment was necessary, to aline the malpositioned $\overline{1}|$ and to correct the Class II malocclusion with a unilateral crossbite (*Fig.* 17).

The next case was referred because of failure of eruption of 21|. On clinical examination there was a slight fullness of the labial sulcus in C-A| region which was of bony hardness. Radiographs revealed the presence of a complex composite odontome (*Fig.* 18 A). At operation, CBA| were extracted and the odontome removed together with a malformed maxillary central incisor and related to the distolateral aspect of the odontome (*Fig.* 19 B). Following irrigation the cavity was packed, the pack being removed after 3 weeks. In this case a denture to replace 21| is required with the possibility of orthodontic treatment at a later date to guide unerupted 3| into good alinement.

A B C

Fig. 19.—A, Unerupted maxillary canine; B, Post-operative X-ray; C, X-ray showing bone regeneration.

Fig. 20.—Giant-cell epulis buccal aspect $\overline{6}|$.

Fig. 21.—Giant-cell epulis in $|\overline{45}$ region.

7. The Unerupted Maxillary Canine.—Where a grossly displaced unerupted maxillary canine is symptomless, orthodontic treatment to bring it into the arch is contra-indicated. Periodic radiographs should be taken to watch for resorption of incompletely formed roots of adjacent teeth or dentigerous cyst formation.

Fig. 19 A illustrates a case in which considerable resorption of the roots of the adjacent maxillary lateral and central incisors had occurred as a result of an unerupted canine. Orthodontic treatment was not indicated. The canine was removed surgically by a palate approach. Healing was uneventful and the

vitality of the maxillary central and lateral incisor was unimpaired. From the radiographs taken subsequently it is seen that regeneration of bone has occurred (*Fig.* 19 A, C).

8. Giant-cell Epulis.—Both cases presented as sessile gingival swellings which had been present for a month or more.

The first case (*Fig.* 20) was symptomless. Treatment consisted of excision of the epulis together with one or two millimetres of surrounding normal mucosa and curettage of the underlying bone.

The second case (*Fig.* 21) complained of a painful swelling which bled when touched. On clinical examination it was observed that the surface of the swelling was ulcerated due to trauma from an opposing carious tooth and subsequent secondary infection. Treatment consisted of excision of the epulis and extraction of the underlying mandibular premolar, which was grossly displaced.

The serum-calcium level was normal in both patients, and radiographs revealed no abnormality of the teeth or underlying bone associated with the swellings.

These cases were shown to demonstrate that it is not necessary to remove teeth adjacent to a giant-cell epulis and thus complicate the occlusion unless the teeth are grossly misplaced.

Acknowledgements.—I wish to thank Mr. R. E. Rix, Mr. K. E. Pringle, and Mr. R. O. Holland for permission to publish cases under their care; Mr. W. J. Tulley for advice and help in compiling this article; and Miss B. Whiteley for the photographs.

REPORTS OF MEETINGS

ORDINARY MEETING, January 13

An Ordinary Meeting of the Society was held at Manson House, 26, Portland Place, London, W.1, on Monday, January 13, 1958, at 7.30 p.m. The President, Mr. J. W. Softley, occupied the Chair.

Minutes

The Minutes of the Annual General Meeting held on Monday, December 16, 1957, were read, confirmed, and signed.

The President announced that the Council would welcome case reports, casual communications, or other short communications to be read before the main paper at any meetings during the present or subsequent years.

The Council was also in need of some demonstrations for the May meeting and if anyone had any which they would like to make he would be glad if they would contact the Secretary.

The President welcomed any visitors and said he hoped they would consider themselves as members for the evening and invited them to take part in any discussion which might follow the paper.

The following candidates for election were admitted *en bloc* by show of hands:—

Mr. K. W. Adam, L.D.S. R.C.S. (Eng.), The White House, Belmont Street, Bognor Regis, Sussex;

Miss S. Adams, B.D.Sc. (Melb.), L.D.S. (Vict.), 23, Sloane Court West, London, S.W.3;

Mr. P. G. Bush, L.D.S. R.C.S. (Eng.), "Marita", 66, Swanpool Lane, Aughton, Nr. Ormskirk, Lancs.;

Mr. A. E. Fisher, B.D.S. (Lond.), 293, Green Lanes, Palmer's Green, London, N.13;

Mr. P. T. Heffer, L.D.S. R.C.S. (Eng.), 22, Russell Mansions, 144, Southampton Row, London, W.C.1;

Mr. M. R. Kean, B.D.S. (N.Z.), M.D.S. (N.Z.), Department of Orthodontics, University of Otago Dental School, Dunedin, New Zealand;

Mr. A. M. MacAlpine, L.D.S., R.F.P.S. (Glas.), 49, London Road, Tunbridge Wells, Kent;

Mr. B. P. Taylor, L.D.S. R.C.S. (Eng.), 49, London Road, Tunbridge Wells, Kent.

Mr. J. W. Softley then delivered his Presidential Address:—

"*The Future for Orthodontics*"

ORDINARY MEETING, February 10

An Ordinary Meeting of the Society was held at Manson House, 26, Portland Place, London, W.1, on Monday, February 10, 1958, at 7.30 p.m. The Immediate Past-President, Professor C. F. Ballard, occupied the Chair.

The Chairman said that Mr. Softley was unfortunately down with 'flu, and according to the Regulations he was himself required to take the Chair. The Secretary would send Mr. Softley a letter on behalf of the Society, wishing him a speedy recovery.

The Minutes of the Meeting held on January 13, 1958, were read by the Secretary and were confirmed and signed as a correct record.

The Chairman said it was with deep regret that he announced the death of Professor J. C. Brash. There was no doubt that all orthodontists knew of his work. He had been an Honorary Member of the Society since his election at the Annual General Meeting in 1929.

As members were aware, he specialized in embryology and in the development of the jaws and teeth, and he was well known for the lectures which the Dental Board asked him to give. He would like to read one excerpt from an appreciation of Professor Brash:—

"To watch his sound judgment and the speed with which he sifted the wheat from the chaff in appraising the theories and contentions of others was an education in itself." That illustrated why his Dental Board lectures were to this day unsurpassed in their analysis of the problems of orthodontists.

Professor Brash was survived by his wife and two children, and the President would write condolences to them.

The meeting stood for a few moments in silence.

Mr. A. E. Fisher and Mr. P. Heffer, whose election had been confirmed at a previous meeting, were introduced to the Chairman and signed the attendance book.

The following four candidates for election were admitted *en bloc* by show of hands:—

Mr. J. J. Hall, B.D.S. (Lond.), L.D.S. R.C.S. (Eng.), The Pond House, Offley, Hitchin, Herts.;

Mr. D. G. Huggins, L.D.S. (U.Birm.), 3 St. John's Wood Road, London, N.W.8;

Mr. J. A. Levason, L.D.S. R.C.S. (Eng.), D.Orth. R.C.S., 72 Chatsworth Road, Brondesbury, London, N.W.2;

Mr. A. H. K. Price, L.D.S. R.C.S. (Eng.), F.D.S. R.C.S., D.Orth. R.C.S., 6 Oxford Street, Nottingham.

The CHAIRMAN welcomed any visitors who might be present and invited them to take part in the discussion, if they so wished.

In introducing Mr. A. D. Dixon, he said Mr. Dixon had commenced anatomy and, indeed, had probably gained his interest in anatomy under Dr. James Scott, of Belfast. That name was well known to many of those present. After Mr. Dixon had qualified, he specialized in anatomy and was now a Lecturer in Anatomy for dental students in the University of Manchester. He had given papers before, one on the growth of the maxilla to the odontological section of the Royal Society of Medicine.

Mr. A. D. DIXON then delivered his paper:—

"*The Development of the Jaws*"

ORDINARY MEETING, March 10

AN ORDINARY MEETING of the Society was held at Manson House, 26, Portland Place, London, W.1, on Monday, March 10, 1958, at 7.30 p.m. The President, Mr. J. W. Softley, occupied the Chair.

The PRESIDENT announced, with regret, the death of Mr. Russell Marsh, who was President of the Society in 1949.

Members stood in silence in tribute to Mr. Marsh.

The Minutes of the previous Meeting, held on February 10, 1958, were read and confirmed.

The following members, whose election had been confirmed at a previous meeting and who were attending for the first time since their election, signed the Obligation Book and were introduced to the President: Mr. D. G. Huggins and Mr. H. Levason.

The following candidates were admitted by show of hands:—

Mr. C. D. Baker, B.D.S. (Lond.), L.D.S. R.C.S. (Eng.), 15, Donnington Road, Kenton, Middlesex;

Miss L. G. Evans, B.D.S. (Lond.), L.D.S. R.C.S. (Eng.), University College Hospital Dental School, London;

Mr. E. W. Park, L.D.S. (Edin.), 60 Halifax Road, Grenoside, Sheffield.

The PRESIDENT welcomed visitors and invited them to regard themselves as members for the evening and take part in the discussion of the paper.

He called on Mr. J. H. Hovell to present his paper entitled:—

"*Some Surgical Procedures related to Orthodontic Treatment*"

JUBILEE MEETING, May 9-10

The CHAIRMAN said he was privileged to welcome members to the Meeting which they were fortunate in being able to hold in the Eastman Clinic. The Society was grateful to the authorities of the Eastman Dental Clinic, to its Director, Professor Wilkinson, and to Professor Ballard for the facilities which had been put at its disposal. He had hoped that Professor Wilkinson would have been present to inaugurate the meeting but unfortunately he was away in Malaya.

The CHAIRMAN formally declared the Jubilee Meeting open.

Visitors were welcomed and asked to consider themselves members of the Society for the duration of the Meeting and to take part in the discussions.

The Minutes of the Meeting held on Monday, March 10, 1958, were read by the Secretary and were confirmed and signed as a correct record.

Mr. J. J. Hall, Mr. A. H. K. Price, Mr. S. H. Alexander, Miss L. G. Evans, and Mr. G. D. Jameson, whose election had been confirmed at a previous meeting, were introduced to the Chairman and signed the attendance book.

Mr. Endacott, Mr. Hope, Miss Lowenberg, Mr. Parker, Mr. Shotts, Mr. Stubley, Mr. Webb, and Miss Webb, candidates for election, were admitted *en bloc* by show of hands.

Programme

Friday, May 9.

9.45 a.m. Paper: Dr. W. R. Burston: "*The Early Orthodontic Treatment of Cleft Palate Conditions*". Opener: Mr. M. A. Kettle.

11.00 a.m. Coffee (Refectory).

11.45 a.m. Paper: Mr. H. L. Leech: "*A Clinical Analysis of Orofacial Morphology and Behaviour of* 500 *Patients attending an Upper Respiratory Research Clinic*". Opener: Professor C. F. Ballard.

1.30 p.m. Luncheon (London House Students' Hostel, close by the Eastman Dental Hospital). A limited number of luncheon vouchers were obtainable on registration at Eastman Dental Hospital.

2.30 p.m. Paper: Mr. G. G. T. Fletcher: "*The Age Factor in Orthodontics*". Openers: Mr. J. R. E. Mills, Mr. W. J. Tulley.

7.00 for 7.30 p.m. Jubilee Dinner, The Savoy Hotel. Dress Formal.

Saturday, May 10.

9.45 a.m. Short Paper: Mr. J. S. Rose: "*Atypical Paths of Eruption: Some Causes and Effects*". Short Paper: Professor Sheldon Friel: "*Determination of the Angle of Rotation of the Upper First Permanent Molar to the Median Raphe of the Palate in Different Types of Malocclusion*".

11.00 a.m. Coffee (Refectory).

11.30 a.m. Short Paper and Film: Dr. W. Grossman: "*Some Observations of the Tongue and Soft Tissue Behaviour in Malocclusions*". Short Film: Dr. T. C. White and Mr. J. Houston: "*Displaced Maxillary Incisors due to Supernumerary Teeth*".

1.30 p.m. Luncheon (London House, Students' Hostel).

2.30–4.00 p.m. Table Demonstrations: Mr. J. Angelman: "*Distal Movement of Premolars and Canines*". Mr. P. Blyth: "*Class III Cases with Failure of Vertical Development*". "*A Filter for Improving Lateral Skull Radiographs*". Mr. C. P. Briggs: "*A Method of Treatment of Angle Class III Malocclusions*". Mr. G. C. Dickson: "*The Inverted Labial Arch—An Aid to Treatment of Class III Malocclusion*". Mr. D. A. Dixon: "*Vestibular Anchorage: A Clinical Experiment.*" Mr. G. B. Hopkin: "*The Rubber Peg Plate*". Mr. M. F. Scott: "*Teaching in Plastic*". Mr. T. Smith: "*Some Cases from General Practice*". Mr. H. G. Watkin: "*Local Applications of the 'Watkin' Appliance*". Mr. W. R. Willcocks: "*Surgery in Relation to the Developing Dentition*". Mr. J. K. Wilkie: "*The Slider: A Removable Coil Spring Appliance for Mesiodistal Tooth Movement*". Mr. H. E. Wilson: "*A Simple Spring to rotate an Incisor*"; "*A Pin-vice to use in making Coil Springs*"; "*Some Interesting Cases of Self-correction*".

Closing the meeting the President said everyone would feel most indebted to the authorities of the Eastman Dental Clinic, to Professor Wilkinson and Professor Ballard for the facilities which had been placed at the disposal of the Society, and for the hard work and organization which had been put into making the Meeting a success. He included in his thanks the staff at the Eastman Clinic, particularly the girls at the desk and the projectionist who had anticipated every move of the lecturers in such a marvellous way and who, with the electrician, would be arranging the demonstrations in the afternoon, giving the Meeting even more reason to thank him, the officials of the Society, the Secretary, Mr. Leech, in particular, and all the others who had contributed to the success of the Society. It was very difficult to express in adequate terms, but on behalf of the Society he thanked all those who had contributed to the success of the meeting—the reporter for the patient way in which she had taken everything down; the readers of the papers for their excellent contributions; the people who had taken part in the discussions for making them provocative and stimulating; and all who had contributed.

The CHAIRMAN officially closed the Meeting. The next Meeting had been fixed for October 13 at 7.30 p.m., at Manson House, when Miss Clinch would speak on:—"*A Longitudinal Study of the Results of Premature Extraction of Deciduous Teeth between* 3–4 *and* 13–14 *Years of Age*".

ORDINARY MEETING, October 13

An Ordinary Meeting of the Society was held at Manson House, 26, Portland Place, London W.1., on Monday, October 13, 1958, at 7.30 p.m.

The President, Mr. J. W. Softley, occupied the Chair.

The Minutes of the Jubilee Meeting were read, confirmed, and signed as a correct record.

Mr. C. D. Parker, Miss Shirley Adams, and Mr. H. D. Astley Hope, whose election had been confirmed at a previous meeting, were introduced to the Chairman and signed the attendance book.

The following five candidates for election were admitted *en bloc* by show of hands:—

Mr. D. G. F. Ardouin, L.D.S. R.C.S. (Eng.), Lakenheath, Southgate, London, N.14;

Miss E. E. Arnheim, B.D.S. (U. Durham), "Dunmore", 12, Hermon Hill, Wanstead, London, E.11;

Mr. A. B. Greenwood, L.D.S. R.C.S. (Eng.), 5 St. Peter's Place, Brighton, Sussex;

Mr. G. A. Kerr, L.R.C.P., M.R.C.S., L.D.S. R.C.S. (Eng.), D.Orth. R.C.S. (Eng.), "Bowen's Lodge", Westerham Road, Keston, Kent;

Mr. J. G. Whitelegg, B.D.S. (Lond.), L.D.S. R.C.S. (Eng.), 83, Heathcote Drive, East Grinstead, Sussex.

The Chairman said he would like to welcome any visitors there might be among those present, and asked them to consider themselves members of the Society for the evening. He hoped they would take part in any discussion which might follow the paper. It was his pleasure to call upon Miss Clinch to read her paper on:—

"*A Longitudinal Study of the Results of Premature Extraction of Deciduous Teeth between* 3–4 *and* 13–14 *Years of Age*".

ORDINARY MEETING, November 10

An Ordinary Meeting of the Society was held at Manson House, 26, Portland Place, London, W.1., on Monday, November 10, 1958, at 7.30 p.m.

The President, Mr. J. W. Softley, occupied the Chair.

The Minutes of the Ordinary Meeting of the Society held on Monday, October 13, 1958, were read, confirmed, and signed as a correct record.

Mr. D. G. F. Ardouin, Miss B. Lowenberg, and Mr. G. Kerr, whose election had been confirmed at a previous meeting, were introduced to the Chairman and signed the attendance book.

The following candidates for election were admitted *en bloc* by show of hands:—

Mr. S. Haynes, B.A.D., Dental School/Hospital, Blundell Street, Leeds, 1;

Mr. D. Jackson, D.D.S., M.D.S., B.D.S., L.D.S., Leeds University Dental School, Blundell Street, Leeds, 1;

Miss P. S. Miller, L.D.S., 47, Gatley Road, Cheadle, Cheshire;

Mr. P. F. G. Whitfield, L.D.S. (U.B'ham), D.Orth. R.C.S. (Eng.), 27, Hyde Road, Paignton, Devon;

Mr. M. B. Gillman, 1693, New Hyde Park Road, New Hyde Park. New York, U.S.A. (Corresponding Member);

Mr. J. Lee Chee Onn, L.D.S. (Singapore), 398-P, River Valley Road, Singapore (Corresponding Member).

Mr. F. F. Robson, L.D.S. R.C.S. (Eng.), Robinson House, Union Avenue, Salisbury, Southern Rhodesia (Corresponding Member).

The Chairman said if there were any visitors present he hoped they would consider themselves members of the Society for the evening, and take part in any discussion which might ensue. He also said how glad those present were to see Mr. Harold Chapman back with them, fully recovered from his operation. (Applause.)

In introducing Prof. Lundström, the Chairman said the name of Lundström was known and honoured wherever orthodontists were to be found. It had been Axel Lundström, his father, who by his studies of the apical base revolutionized orthodontic thinking. The fame of the father might have made it difficult for the son to follow, but the son was not diminished in stature by comparison with his father. His own contributions to orthodontics had added to the lustre of the family name and had secured for him his own right to acknowledgement.

Professor Lundström, a Member of the Society, Professor of Orthodontics in a Dental School in Stockholm, then presented the Twelfth Northcroft Memorial Lecture:—

"*How much can we hope to reduce the Incidence of Malocclusion through Prophylactic Measures?*"

ANNUAL GENERAL MEETING, December 8

The Annual General Meeting of the Society was held at Manson House, 26 Portland Place, London, W.1, on Monday, December 8, 1958, at 7 p.m. It was followed by a paper read by Dr. R. B. Dockrell. The retiring President, Mr. J. W. Softley, occupied the Chair for the first part of the proceedings, and the incoming President, Professor G. E. M. Hallett, after his induction.

Minutes.—The Minutes of the Ordinary Meeting held on Monday, November 10, 1958, were read, confirmed, and signed.

Election of Officers and Councillors.—The President said that there were no other nominations and he had therefore to announce that the officers and councillors for 1959 nominated by the Council, as printed on the agenda paper, were duly elected.

Election of two Auditors.—On the motion of Mr. E. K. Breakspear, seconded by Mr. G. C. Dickson, the present auditors were re-elected.

Report of the Treasurer.—The Treasurer (Mr. J. S. Beresford) presented his report, as follows:—

The attention of Members is drawn to the relief from Income Tax in respect of our annual subscriptions which is now available to those assessable under Schedule "E". It is my intention to suggest to the Council that the Statement of Accounts be no longer printed in the bound copy of the *Transactions*. This would be some saving in printing costs and I do not see why copies of our financial records should be preserved for posterity in the libraries of dental schools all over the world. I am happy to report an excess of Income this year.

On the motion of the Treasurer, seconded by Mr. A. G. Taylor, the report was received.

Mr. Harold Chapman said he was not sure that he agreed with Mr. Beresford's suggestion to ask the Council not to print the accounts in the *Transactions*. He thought that to-day it might be a matter of public interest only to a few people perhaps, but maybe in one hundred years' time it would be a matter of interest to many. He would ask Mr. Beresford to think again.

The Treasurer thanked Mr. Chapman for his observations, and said his remarks were always wise and helpful and he would certainly bear them in mind.

A motion by the President from the Chair that the report be adopted was carried.

Report of the Secretary.—The Secretary (Mr. H. L. Leech) presented his report as follows:—

In the twelve months from December, 1957, to November, 1958, seven meetings of this Society have been held with an average attendance of 112 members and visitors per meeting, which is a slight increase on the previous years due mainly to the attendance at the Jubilee Meeting.

During the year 35 new members have been elected, there have been 5 resignations, and 3 deaths, including those of 2 of the Honorary Members, and the membership as at December 31, 1958, is expected to be 491.

The Jubilee Meeting, celebrating fifty years since the Society was founded, was held in May and took the form of a two-day conference with the amenities of the Eastman Dental Hospital, London, very kindly placed at the Society's disposal. Amongst the distinguished guests and members, some from overseas, was one of the original Founder Members, Mr. Harold Chapman.

During my term of office as Secretary for the past four years, two Country Meetings, at Sheffield and Newcastle upon Tyne, have been held. This represented a departure from the usual policy of the Society where previously all the meetings had been confined to London, but has proved so successful that a further Country Meeting will be held in Manchester during April of next year.

A complete revision of the Society's By-Laws has also taken place, with a resulting increase in the establishment for Officers and Councillors and a greater representation on

the Council of members outside the London area.

During these four years the membership has increased from 393 to 491, and it might be necessary, in the not too distant future, to question whether our present accommodation at Manson House will be sufficient for the Society's needs.

With these confident prospects for the future I pass on the Secretaryship to the capable hands of Mr. B. C. Leighton with a wish that the years of office for him will be as happy as they have been for me.

May I move the reception of this Report?

On the motion of Mr. H. L. LEECH, seconded by Mr. W. J. TULLEY, the report was received. Mr. BREAKSPEAR said he would like to take this opportunity of expressing from the floor the thanks of the Society for the work done on its behalf.

A motion by the PRESIDENT from the Chair that the report be adopted was carried.

Report of the Librarian.—The LIBRARIAN (Mr. A. G. TAYLOR) presented his report, as follows:—

In the past year the library has been very fortunate to receive gifts of books, reprints, and journals from Dr. R. X. O'Meyer, Professor R. Hotz, Messrs. J. A. Rose, W. Warwick James, Mrs. M. Michaelis, Mr. H. E. Wilson, and Mr. Harold Chapman. To all these the Society is indebted for their splendid generosity.

The amount of material borrowed from the library by members is almost the same as last year, 1957.

The sales of current and past *Transactions* continue to mount and most of these volumes are sold abroad. There are also exchange arrangements whereby we receive Transactions of the French and Spanish Orthodontic Societies, the Roumanian Dental Journal, and the American Journal of Orthodontics.

On the motion of Mr. A. G. TAYLOR, seconded by Mr. D. T. HARTLEY, the report was received.

A motion by the President from the Chair that the report be adopted was carried.

Report of the Editor.—The EDITOR (Mr. W. J. TULLEY) presented his report, as follows:—

I am pleased to be able to report that the *Transactions* for 1957 were published well before the end of this year. They are shorter than the previous year because there was no Country Meeting in 1957. I think you will agree that Messrs. John Wright & Sons Ltd. of Bristol are making an excellent job of the *Transactions* and we continue to enjoy a very happy liaison with them.

During this year we have changed to a new method of presentation in the *Dental Practitioner*. The Society is financing part of the Supplement to enable us to have up to twenty pages in each issue and this means that we can always print the discussions and that this Supplement can be "run on" so that the *Transactions* will cost relatively less. As I reported last year the success of this new method will depend on receiving papers promptly. There are still a number of outstanding demonstrations from our Jubilee Meeting which I shall be pleased to receive, but we have all the papers to date with the exception of the Northcroft Lecture.

Heads of Departments and Teachers in the various Schools are urged to encourage members of their Staff to produce case reports to be read as short communications, so that we may keep a balance between the practical and the theoretical aspects of our subject.

May I move the acceptance of this Report?

On the motion of Mr. TULLEY, seconded by Mr. S. G. MCCALLIN, the report was received.

The TREASURER said that when there was delay in the delivery of papers to the Hon. Editor, he always urged the latter to publish without those papers.

A motion by the PRESIDENT from the Chair that the report be adopted was carried.

Report of the Curator.—The CURATOR (Miss L. M. CLINCH) presented her report as follows:—

The Museum is still housed next door at the Institute of Public Health and Hygiene, 28, Portland Place. It is open between 10 a.m. and 5 p.m. on week-days.

During the year serial models showing an unusual order of eruption of the teeth were presented by Mr. MacGillivray; a case of absence of the first permanent molars by Mr.

Roberts; and a case of transposition of the upper central and lateral incisors by Mr. Hart.

The album of photographs of the presidents of the Society is up to date except for the years 1953, 1955, and 1958.

I am still trying to form a collection of appliances from the earliest types up to those in use to-day. If any members have any early types of appliances I would be grateful if they would give them to the Museum.

On the motion of Miss CLINCH, seconded by Mrs. M. E. H. DAVIS, the report was received.

A motion by the PRESIDENT from the Chair that the report be adopted was carried.

A motion by the PRESIDENT from the Chair that the following candidates be elected *en bloc* was carried:—

Mr. J. C. Bailey, L.D.S., Turner Dental School, Bridgeford Street, Manchester, 15;

Mr. R. Marx, B.D.S., L.D.S., 15 Beehive Green, Welwyn Garden City, Herts.;

Mr. L. B. Whittaker, L.D.S., 55 Talbot Road, Fallowfield, Manchester, 14.

The SECRETARY, correcting a misprint on the agenda, announced that a two-day Country Meeting in Manchester would be held on Friday, April 17, and Saturday, April 18, 1959.

The Secretary also announced an invitation from the British Society of Periodontology at the Eastman Dental Hospital on January 12, 1959, at 5 p.m., at which a paper would be read by Mr. Tulley on orthodontic treatment and the periodontal tissues. The opener of the discussion would be Mr. Wilson.

The PRESIDENT announced that the business of the Annual General Meeting was concluded.

Guests and visitors were then admitted.

Mr. K. E. PRINGLE said it was customary for a member from the body of the hall, at this stage and at the final meeting of the year, to propose a vote of thanks to the retiring President. He was sure the meeting would like to thank Mr. Softley very much indeed for the careful, tactful, and friendly manner in which he had conducted the meetings during the year. It had been a year of great responsibility, including the Jubilee Meeting, and Mr. Softley had helped to make it a very happy year for the Society.

In the vote of thanks he would like to include the other officers who had again served the Society so well. (Applause.)

PRESIDENT'S VALEDICTORY ADDRESS

The PRESIDENT thanked Mr. Pringle, and said that he would remember the privilege of the presidency of the B.S.S.O. during the past year with pride and with pleasure. He thought he could say without sacrificing any modesty that it had been a successful year, but that had not been due—in spite of anything Mr. Pringle might have said—to the contribution which the President had made. The success of a society depended on the energy, enthusiasm, and efficiency of the permanent officials. A member of a society knew in a vague sort of way that the officials did a certain amount of work, but when one was on the Council one realized that to a somewhat greater extent. As President, one eventually came to the full realization that they did, in fact, work very hard indeed on behalf of the society to make everything a success. He himself, in common with his predecessors, had reason to be thankful for them and he acknowledged that very gratefully.

He would in particular like to single out Mr. Leech, the retiring Secretary. An official vote of thanks had been given earlier on in the meeting but now there were more present he would again like to remind the meeting of Mr. Leech's four years as Secretary, for which he deserved the very best thanks.

The policy of holding Country Meetings, and, in the past year, the Jubilee Meeting had of course placed a great strain on the contributors to the meetings. If it was agreed that the officers did a great deal of work for the Society, there was one way in which members could lighten their burden. That was for those who had contributions to make to the Society to write of their own volition to the Secretary. Their names would then be put on the list of future contributors. Those who needed some assistance could also write to the Secretary and the Editorial Committee would assist them with advice, and also active help if so desired.

He would like to thank the members of the Council and all the members of the Society

who had made his year a very memorable one indeed.

Induction of New President.—The PRESIDENT inducted PROFESSOR G. E. M. HALLETT as the new President and handed over to him the chain of office.

PROFESSOR G. E. M. HALLETT then took the Chair. He thanked the Society for the honour they had done him in electing him President.

After announcing that there would be a Presidential Address in January, 1959, the PRESIDENT declared the meeting closed.

THE BRITISH SOCIETY FOR THE STUDY OF ORTHODONTICS

Balance Sheet and

Income and Expenditure Account

FOR THE YEAR ENDED SEPTEMBER 30, 1958

FREDK. B. SMART & COMPANY, CHARTERED ACCOUNTANTS

22 Queen Street, London E.C.4

The British Society for the Study of Orthodontics

INCOME AND EXPENDITURE ACCOUNT for the year ended 30th September, 1958

1957											
£	s.	d.		£	s.	d.	£	s.	d.	£	s. d.
10	10	0	To Museum Rent				10	10	0		
127	10	2	,, Printing and Stationery	110	14	5					
–	–	–	,, Cost of *Transactions*, 1956	647	1	2					
850	7	0	,, Reserve for Cost of *Transactions*	–	–	–					
75	0	0	,, Reserve for *Practitioner*	–	–	–					
141	9	0	,, *Practitioner* Extra Cost of Printing	43	15	0					
							801	10	7		
34	17	11	,, Postage				56	6	5		
14	11	0	,, Lantern and Film Expenses				5	0	0		
54	0	0	,, Hire of Hall				46	13	0		
39	12	6	,, Reporting				84	12	0		
76	9	0	,, Refreshments				126	17	2		
–	–	–	,, Jubilee Meeting				57	7	2		
8	8	0	,, Audit and Accountancy				12	12	0		
3	8	6	,, Insurance				4	3	6		
4	19	6	,, Library and Journals				7	17	6		
26	5	0	,, Northcroft Memorial Lecture				26	5	0		
23	2	0	,, Honoraria				23	2	0		
7	15	8	,, Sundry Expenses				11	2	4		
34	4	0	,, Depreciation on Furniture and Equipment				34	4	0		
–	–	–	,, *Excess of Income over Expenditure for the year*				312	1	10		
£1,532	9	3					£1,620	4	6		

1957											
£	s.	d.		£	s.	d.	£	s.	d.	£	s. d.
			By *Members' Subscriptions:*—								
			1958 Subscriptions	1,320	13	6					
1,318	16	1	Adjustment in respect of Past Years	51	15	5					
							1,372	8	11		
70	6	7	,, Sale of *Transactions*							122	14 5
25	0	0	,, Interest on Savings Certificates	15	0	0					
17	5	4	,, Interest on $2\frac{1}{2}\%$ Consolidated Stock	17	5	4					
20	0	0	,, Interest on 4% Consolidated Stock	20	0	0					
17	10	0	,, Interest on $3\frac{1}{2}\%$ Defence Bonds	17	10	0					
5	14	5	,, Interest on $5\frac{1}{4}\%$ Hertfordshire County Council Stock	18	2	4					
3	11	11	,, Interest on $5\frac{1}{4}\%$ Corporation of London Stock	15	2	0					
21	11	0	,, Interest on Post Office Savings Bank Account	22	1	6					
										125	1 2
32	13	11	,, *Excess of Expenditure over Income for the Year*							–	– –
£1,532	9	3								£1,620	4 6

The British Society for the Study of Orthodontics

BALANCE SHEET as at 30th September, 1958

1957									1957								
£	s.	d.		£	s.	d.	£	s.	d.	£	s.	d.		£	s.	d.	£	s.	d.
			Accumulated Fund:—										*Furniture and Equipment:—*						
			Balance at 1st October, 1957 ..	3,348	5	0							Balance at 1st October, 1957 ..	336	17	0			
			Add Excess of Income over Expenditure for the year	312	1	10				336	17	0	*Less* Depreciation at 5% per annum	34	4	0			
3,348	5	0					3,660	6	10								302	13	0
			Creditors:—										*Investments:—*						
			Transactions 1957 and 1958 (estimated by the Hon. Treasurer) ..	1,200	0	0				450	0	0	600 National Savings Certificates, at cost plus accrued Interest ..	465	0	0			
1,200	0	0											£691 5s. 10d. 2½% Consolidated						
			Dental Practitioner Short Fall							575	14	0	Stock at Cost	575	14	0			
150	0	0	Account	150	0	0							£500 0s. 0d. 4% Consolidated						
			Dental Practitioner Extra Cost of							485	6	3	Stock at Cost	485	6	3			
141	9	0	Printing	20	0	0							£500 0s. 0d. 3½% Defence Bonds						
26	5	0	Northcroft Memorial Lecture ..	26	5	0				500	0	0	at Cost	500	0	0			
27	0	0	Hire of Hall	27	0	0							£600 0s. 0d. 5¼% Hertfordshire						
7	17	6	Museum Rent	7	17	6				597	9	6	County Council Stock at Cost	597	9	6			
7	17	6	Subscriptions in Advance ..	12	17	6							£500 0s. 0d. 5¼% Corporation of						
25	5	0	Printing and Stationery	–	–	–				508	10	9	London Stock at Cost	508	10	9			
3	13	1	Postage	–	–	–							(Approximate Market Value £2,710)				3,132	0	6
8	8	0	Audit and Accountancy	–	–	–							*Cash at Bank:—*						
13	15	4	Refreshments	–	–	–				613	6	11	Westminster Bank Limited ..	759	3	2			
							1,444	0	0	883	12	9	Post Office Savings Bank ..	905	14	3			
																	1,664	17	5
													Cash in Hand:—						
										5	4	8	Honorary Treasurer	1	17	6			
										3	13	7	Honorary Secretary	2	18	5			
																	4	15	11
£4,959	15	5					£5,104	6	10	£4,959	15	5					£5,104	6	10

S. B. NEWTON, T. L. WINN } *Hon. Auditors*
J. S. BERESFORD, *Hon. Treasurer*

Certified in accordance with the Books and Vouchers of the Society.
We have verified the Investments and Cash at Bank.
FREDK. B. SMART & CO.,
Chartered Accountants,
22, Queen Street, London, E.C.4.

7th November, 1958.

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